STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY
Horace R. Collins, Chief

Report of Investigations No. 79

LAKE ERIE PHYSICAL LIMNOLOGY CRUISE, MIDSUMMER 1967

by

Charles E. Herdendorf

Columbus
1970

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INTRODUCTION

The first comprehensive limnological surveys of Lake Erie were made in the late 1920's. In that period, Wright (report published in 1955) conducted studies in western Lake Erie and Fish (report published in 1960) directed investigations in central and eastern Lake Erie. These studies were made as a result of the collapse of the cisco fishery and reduced catches of other high-value fish. Pollution was thought to be responsible for these problems, but the early surveys failed to detect either the subtle changes that were probably taking place or any deterioration of the environment and the lake was reported as being generally free from pollution. However, using these and other early studies as a base, more recent studies by Beeton (1961, 1965), Carr and Hiltunen (1965), and others have shown that the environmental conditions in Lake Erie appear to have changed at an accelerated rate in the past ten to fifteen years and that the status of the lake as a freshwater resource has become uncertain.

In July and August 1967 a cruise was undertaken to provide new information on the physical limnology of Lake Erie, with particular attention to circulation patterns and to changes that occur in the quality of the water as it passes through the lake. The objective of the field survey was to measure several physicochemical properties of Lake Erie water from its major inflow at the Detroit River to outflow in the Niagara River. This was done by making thirteen transects across Lake Erie and its connecting waterways. Observations of water properties and movements were made at 110 stations, and in most cases consisted of profile measurements with readings and samples taken at various depths from surface to bottom from aboard the Ohio Division of Geological Survey research vessel, *GS-1*. The properties and conditions investigated on the cruise were (1) water temperature, (2) specific conductance, (3) water color, (4) transparency, (5) hydrogen-ion concentration (pH), (6) dissolved-oxygen content, (7) chloride-ion concentration, (8) turbidity, (9) currents, (10) waves, (11) water level, (12) meteorological conditions, (13) water depth, and (14) bottom deposits. The study was completed within a two-week period to give the data collected some degree of synopticity.

ACKNOWLEDGMENTS

Financial support for the western Lake Erie portion of this study was received from the U.S. Department of Interior, Bureau of Commercial Fisheries and Bureau of Sport Fisheries and Wildlife, under the Anadromous Fish Program, Project AFCS-1. Data from the physical limnology cruise, where applicable, is incorporated into the AFCS-1 project report.

METHODS OF INVESTIGATION

Cruise pattern

Field measurements were made from aboard the Ohio Division of Geological Survey research vessel, *GS-1*, between July 25 and August 7, 1967. The *GS-1* cruised over 500 miles, from Lake St. Clair to the Niagara River, making 13 transects across Lake Erie and its connecting waterways. A series of 110 stations were established at one-fourth-mile to five-mile intervals along the transects. Probe measurements of selected water properties were made at each of the stations; current measurements were made and water and bottom deposit samples were taken at approximately half of the stations. Nearly all of the stations were the profile type, with measurements and samples taken at

several depths from surface to bottom. The transect lines will be referred to as profile lines in this report. The locations of the profile lines and stations are illustrated in figures 1 and 2 and other pertinent information is listed in table 1.

Physicochemical measurements

Several physicochemical properties of Lake Erie water were recorded at each station. Probe measurements of temperature and conductivity (specific conductance) and visual observations of color and transparency were made at all stations. Hydrogen-ion concentration (pH), dissolved-oxygen content (DO), chloride-ion concentration, and turbidity were determined for water samples from approximately half of the stations.

Water temperatures were measured in Fahrenheit degrees with electronic probes at intervals of 2.5, 5.0, or 10.0 feet from surface to bottom at all stations. An Applied Research/Austin TF-3 hydrographic thermometer and a temperature sensor fitted to a portable conductivity meter probe were used to obtain measurements. A Woods Hole Oceanographic Institution type bathythermograph, on loan from the Department of the Navy, was also used to obtain graphic traces of temperatures, plotted against depth, at selected stations.

Specific conductance readings were taken with an Industrial Instruments RB-3 conductivity meter. The meter was connected to a weighted probe on a 200-foot cable and was lowered to depths that corresponded with those at which temperature measurements were made. The meter registers specific conductance values in micromhos/cm referenced to 25°C.

Water color was recorded at each station by visual observation in the shade of the ship's hull. Water transparency was determined by lowering a 20-cm Secchi disc until it was no longer visible.

Samples of surface and bottom water were taken at 53 stations with a modified Kemmerer-type PVC plastic water sampler, designed to collect a horizontal column of water. The samples were stored in 8-ounce glass bottles for analysis for four chemical constituents either underway or at the completion of each day's cruise.

Hydrogen-ion concentration (pH) was determined

TABLE 1.—*Lake Erie physical limnology profile lines*

Profile line		Location	Date	Stations	Length (mi)
Lake St. Clair	P-1	Grosse Pointe, Michigan, to Belle River, Ontario	7-25-67	6	12.5
Detroit River	P-2	River Rouge, Michigan, to Ojibway, Ontario	7-25-67	3	0.5
Western Lake Erie	P-3	Colchester, Ontario, to Stony Point, Michigan	7-26-67	8	17.5
	P-4	Stony Point, Michigan, to Port Clinton, Ohio	7-26-67	8	28.0
	P-5	Oxley, Ontario, to Catawba Island, Ohio	7-27-67	9	28.0
Central Lake Erie	P-6	Huron, Ohio, to Pelee Point to Erieau, Ontario	7-30-67	11	65.0
	P-7	Erieau, Ontario, to Cleveland, Ohio	7-31-67	16	67.5
	P-8	Fairport, Ohio, to Port Stanley, Ontario	8-2-67	14	61.0
	P-9	Port Burwell, Ontario, to Conneaut	8-3-67	12	47.0
Eastern Lake Erie	P-10	Erie, Pennsylvania, to Long Point to Port Dover, Ontario	8-5-67	11	50.0
	P-11	Port Maitland, Ontario, to Dunkirk, New York	8-6-67	6	25.0
	P-12	Sturgeon Point, New York, to Point Abino, Ontario	8-7-67	3	9.0
Niagara River	P-13	Niagara River at Buffalo, New York	8-7-67	3	4.0

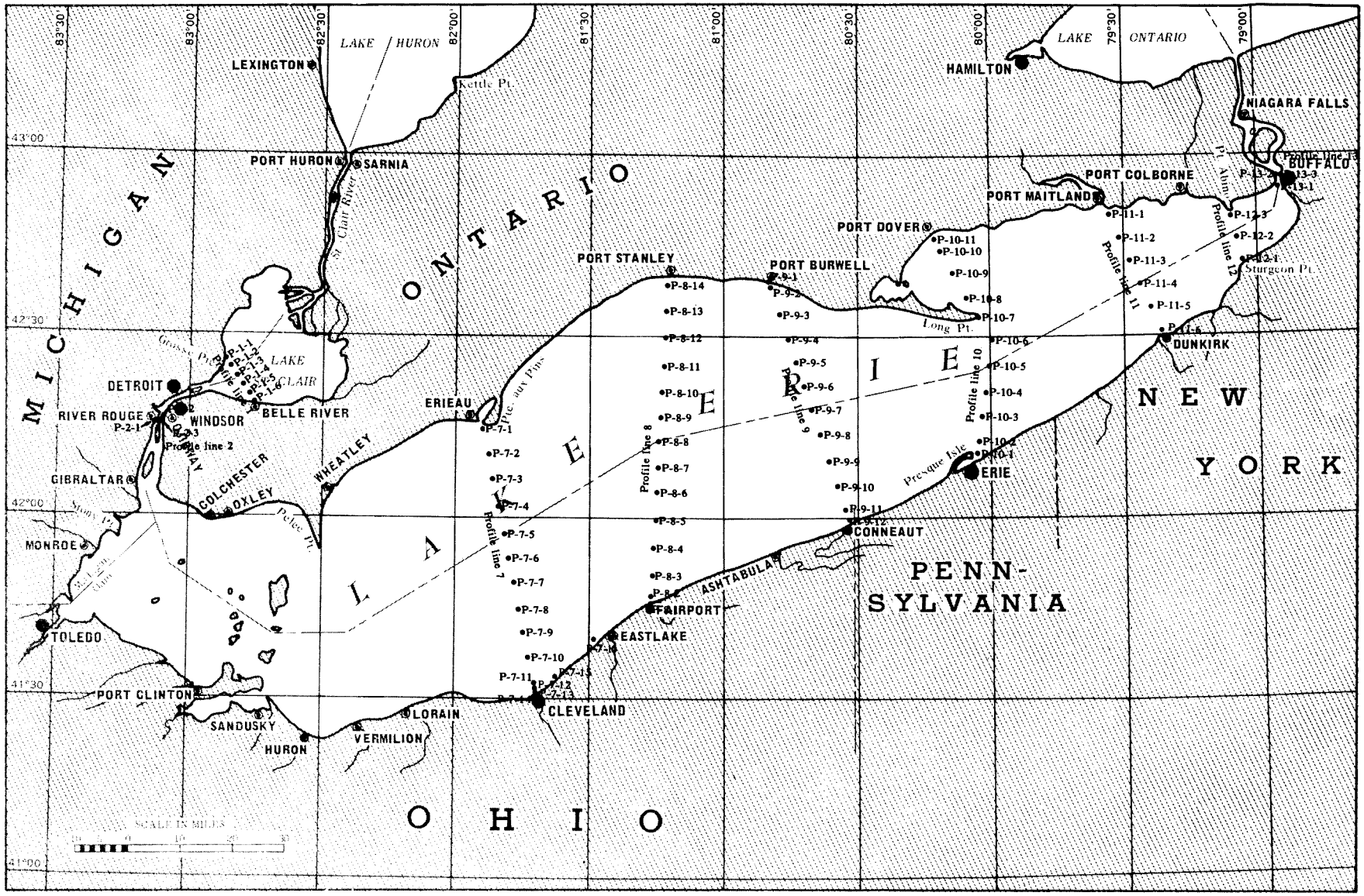


FIGURE 1.—Lake Erie location map showing physical limnology field stations, July 25 to August 7, 1967 (see fig. 2 for field stations on profile lines 3-6).

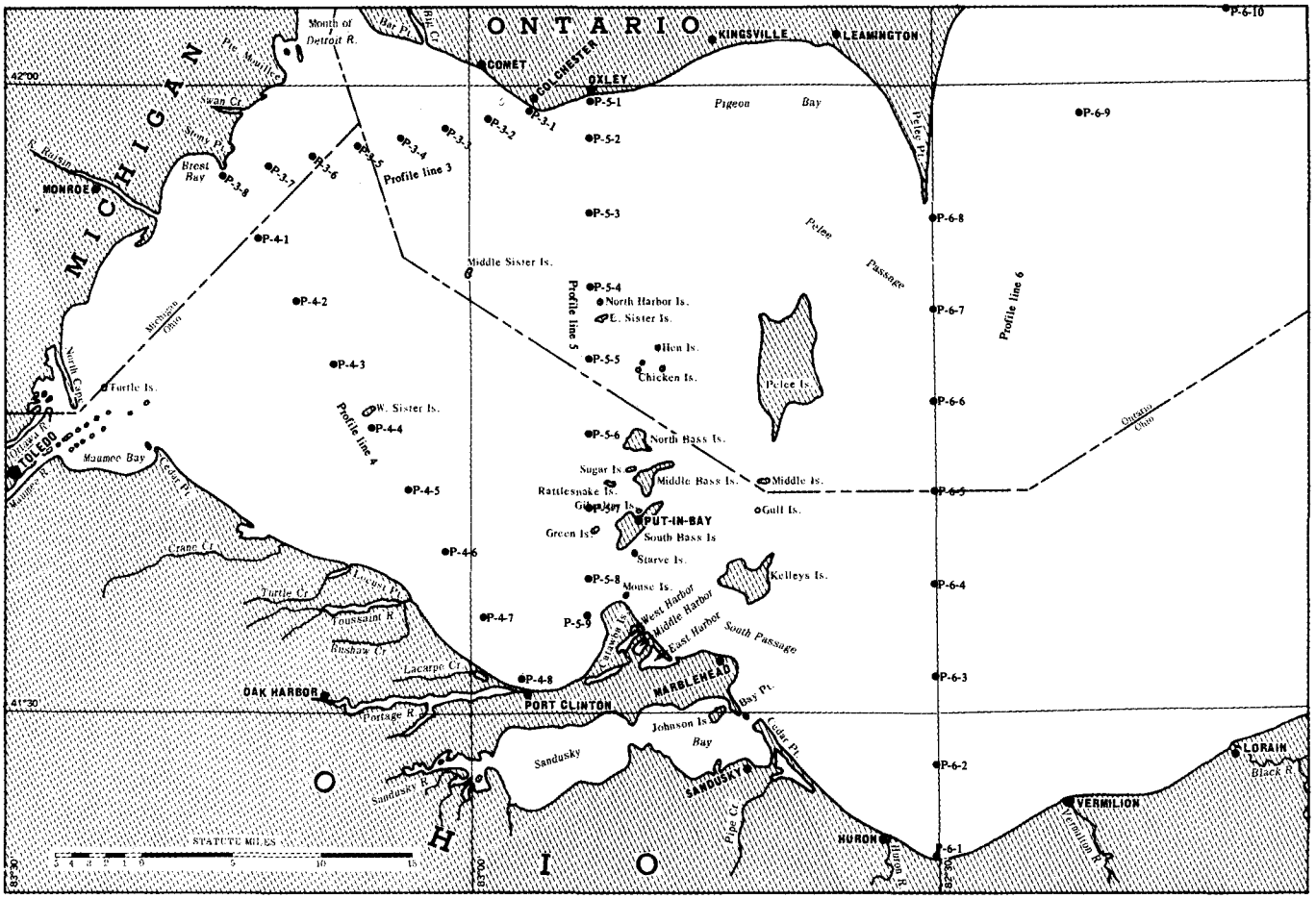


FIGURE 2.—Location map of western Lake Erie.

colorimetrically with a Hach DR Colorimeter and a Hach wide-range (pH 4-10) indicator solution.

Dissolved-oxygen content (DO) in ppm was obtained by the Winkler Method (azide modification), using phenylarsene oxide (PAO) in place of sodium thiosulfate solution.

Chloride-ion concentration in ppm was determined by silver nitrate titration of chloride (Hach modification of Argentometric Method).

Turbidity was measured with a Hach DR Colorimeter, which registers values in Jackson Turbidity Units (jtu).

Current, wave, and water level measurements

Currents were measured at 53 stations throughout the lake. The research ship was stabilized at each station with a bow and two stern anchors before measurements were begun. Surface currents were measured with a drift drogue attached to 100 feet of light line. The drift drogue consists of a 1-foot-long watertight cylinder, 6 inches in diameter, with four 6-inch blades. The cylinder was filled with enough water to cause it to be suspended just below the surface. The line was attached to a staff extending above the cylinder. The time required for the current to pull the length of line taut was recorded and converted to velocity in feet per second. Surface current direction was determined by comparison of the drogue's path with the ship's compass.

Subsurface currents, at 5- or 10-foot intervals from the 5-foot level to a few feet above the bottom, were measured with a Hydro Products Model 460-A Current Speed Sensor and a Model 465-A Current Direction Sensor. This system consists of a Savonious rotor and direction vane which transmits electrical impulses to a dial readout unit on shipboard.

Waves were observed for (1) direction, (2) height, (3) length, and (4) period. Direction was determined from the ship's compass; height and length were visual estimates against markings on the hull of the ship, and the period was timed with a stop watch.

Lake Erie water level data during the period of the study were obtained at the Detroit River mouth (Gibraltar, Michigan), Toledo, Marblehead, Cleveland, Erie, and Buffalo from gages operated by the U.S.

Army, Corps of Engineers, U.S. Lake Survey District, and were obtained at Port Colborne, Port Dover, Port Stanley, and Erieau from recorders maintained by the Water Research Branch of the Canadian Department of Energy, Mines, and Resources.

Meteorological observations

Meteorological observations were made at each station on wind velocity and direction and on air temperature. Wind velocities were measured in miles per hour with a Danforth-White cup-type anemometer; directions were obtained by using flags, referenced to the ship's compass, as wind vanes. Air temperatures were taken with a hand thermometer held in the shade approximately 5 feet above the water line.

Sediment sampling and depth soundings

Bottom sediments were sampled at selected stations with a La Fond-Dietz snapper-type sampler and short cores were taken with an Alpine 100-pound gravity corer and by a SCUBA diver using plastic tubing. Bottom material was also retrieved from the flukes of the anchors at several other stations. Field descriptions were recorded for all samples and the samples were stored in glass jars or plastic tubes for future grain-size analysis and mineral identification.

Depth soundings were made at all stations with a Bendix DR8A recording echo sounder mounted aboard the *GS-1*.

RESULTS OF INVESTIGATION

Physicochemical properties

Temperature.—Water temperature data gathered during the cruise is summarized in table 2. The average profile temperature of Lake Erie water was 68.2°F. Water of the shallow western basin was about 5° above the average and of the deeper basins a little more than 2° below the average.

The distribution of surface water temperatures (fig. 3) shows (1) colder midchannel Detroit River flow that has entered western Lake Erie and then flowed southward and eastward, (2) western basin water that has entered the central basin through Pelee Passage and then moved northeastward along the Canadian shore and, to a lesser extent, southeastward toward the

TABLE 2.—*Lake Erie temperature summary*

Profile line or lake area	All measurements		Surface measurements		Bottom measurements		Surface to bottom difference	
	Number of readings	Average temperature (°F)	Number of readings	Average temperature (°F)	Number of readings	Average temperature (°F)	Number of stations	Average temperature difference (°F)
P-1	46	70.5					6	1.0
P-2	27	70.2					3	1.0
P-3	62	72.9					8	1.5
P-4	55	74.3					8	2.1
P-5	76	73.6					9	0.3
P-6	145	66.7					11	11.9
P-7*	193	65.7					12	12.9
P-8*	203	64.7					13	19.6
P-9	155	67.1					12	12.9
P-10	170	60.5					11	16.3
P-11	105	65.1					6	17.0
P-12	34	71.8					3	2.8
P-13	3	72.1					--	--
Lake Erie and connecting waterways	1,274	68.9	109	71.1	102	63.5		
Lake Erie	1,198	68.2	98	71.1	93	61.2	93	11.0
Western basin	193	73.6	25	74.2	25	73.0	25	1.2
Central basin	696	66.0	53	72.0	48	56.6	48	15.8
Eastern basin	309	65.8	20	71.9	20	57.5	20	14.4

* Exceptionally high readings in Cleveland and Fairport harbors excluded.

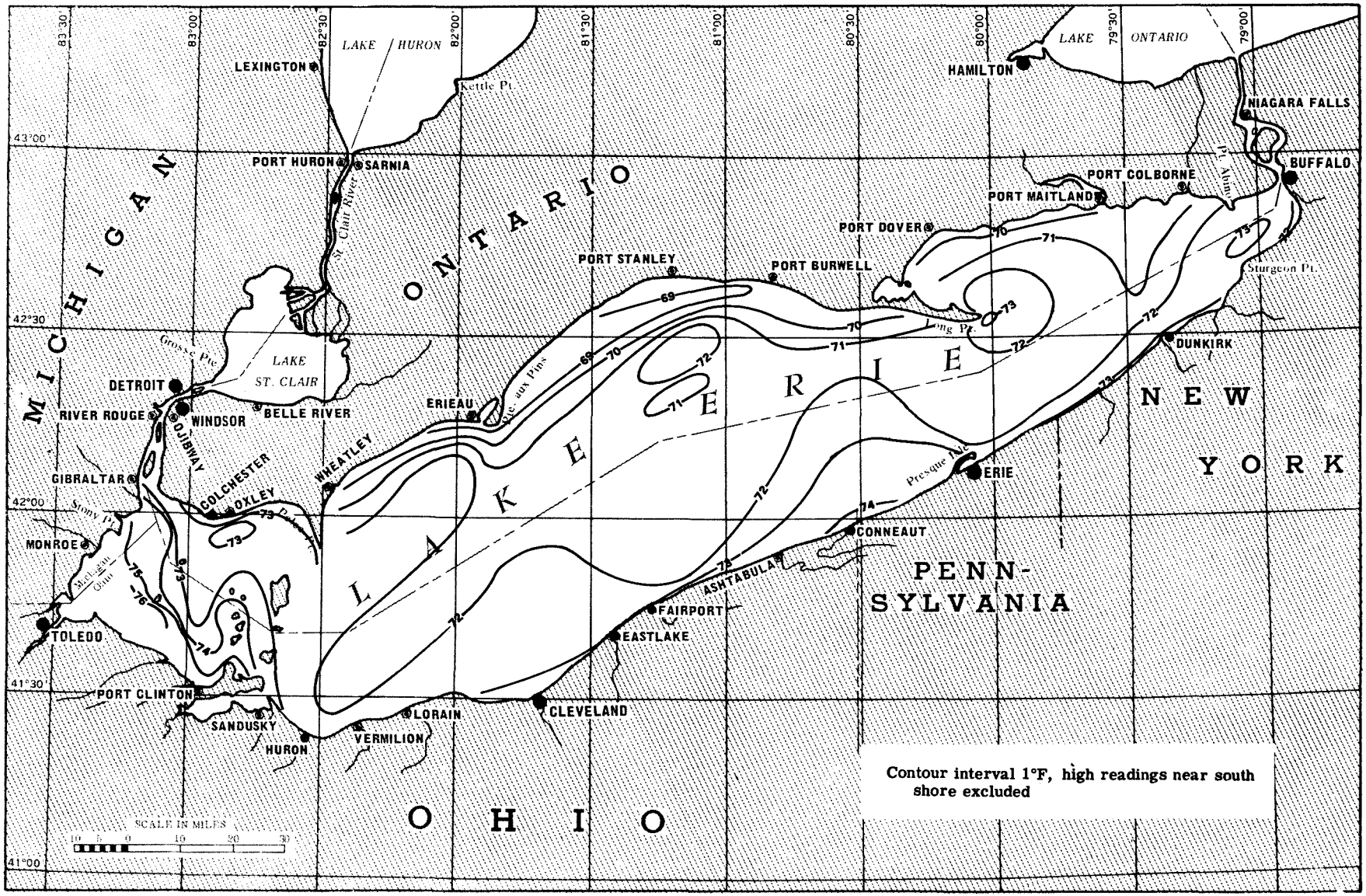


FIGURE 3.—Distribution of Lake Erie surface-water temperature.

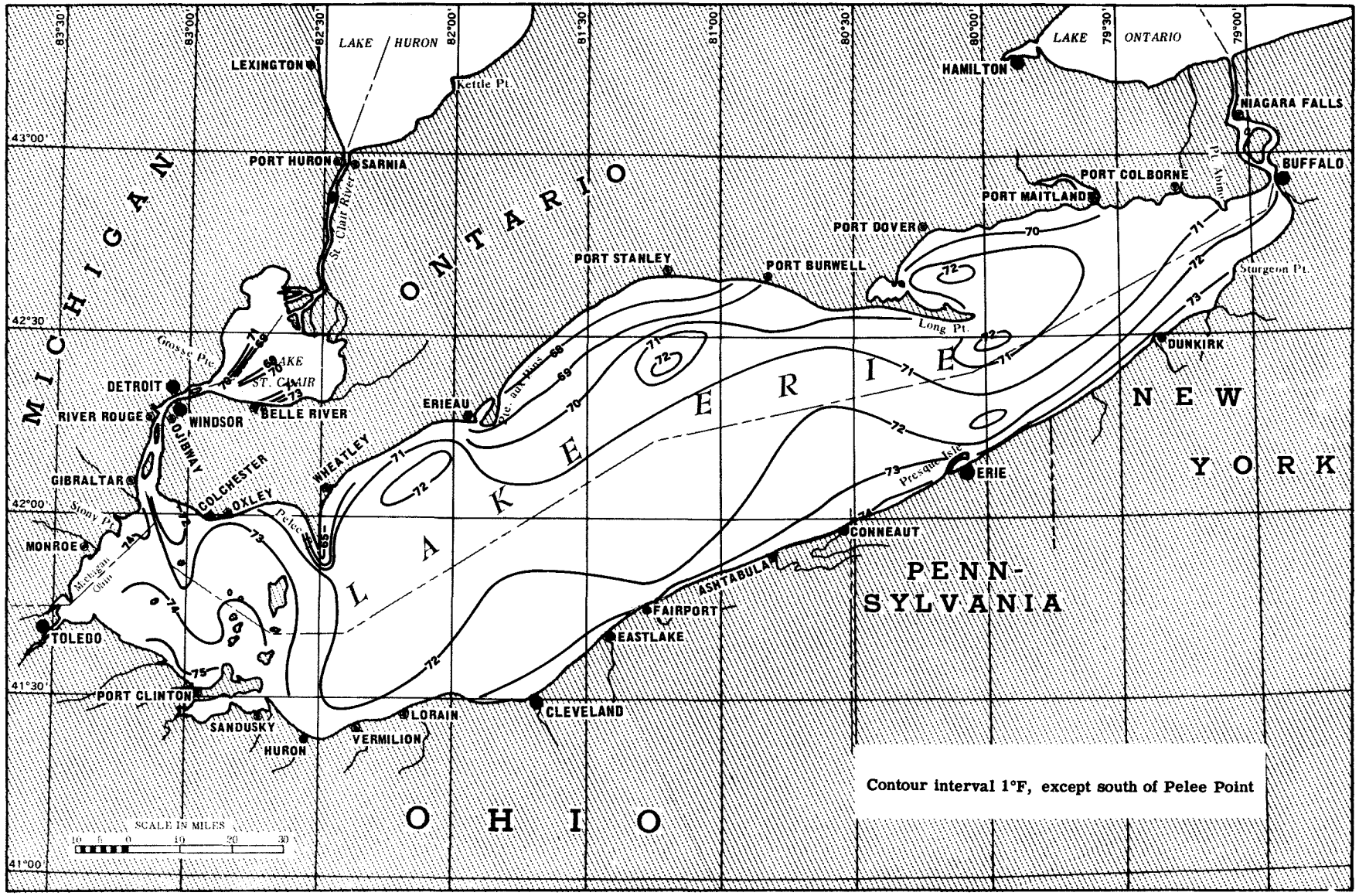


FIGURE 4.–Distribution of Lake Erie 10-foot-depth water temperature.

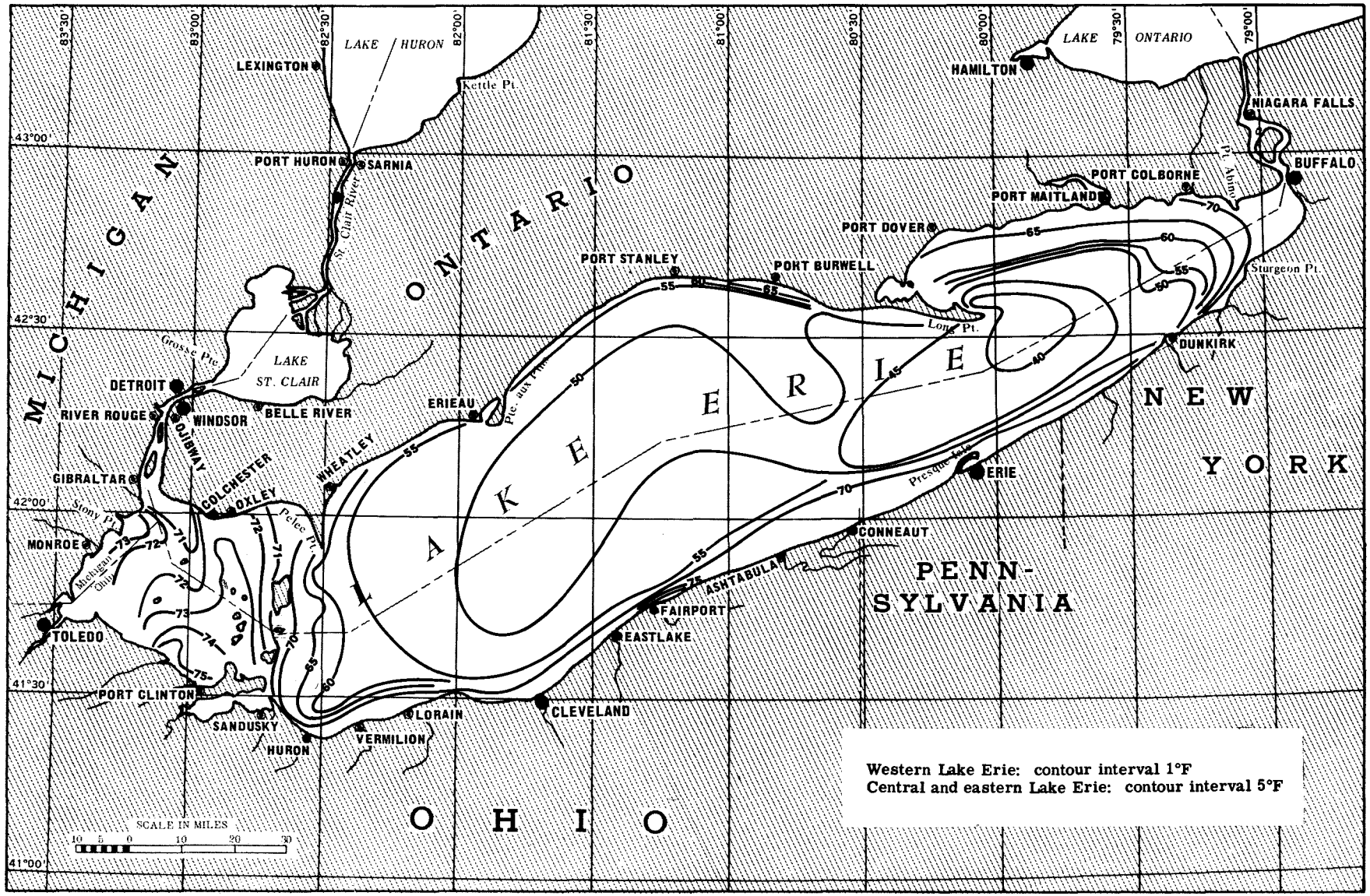


FIGURE 5.—Distribution of Lake Erie bottom-water temperature.

American shore, (3) a decrease in surface temperature of over 4°F from the south shore to the north shore of the central basin, and (4) fairly uniform surface temperatures in the eastern basin. To avoid the effects of diurnal temperature fluctuation in the surface water, temperatures at the 10-foot depth were also plotted (fig. 4). The patterns were similar to those of the surface water but show more pronounced Detroit River flow and upwelling of cooler water along the Canadian shore of the central basin.

Bottom water temperatures (fig. 5) indicated nearly isothermal conditions in the western basin; average temperature difference between surface and bottom water was only 1.2°F. The deeper basins showed an average decrease of about 15° from surface to bottom. The lowest temperatures for the three basins were: western, 70.8° (Station P-3-3, near mouth of Detroit River); central, 49.0° (Station P-8-9, near center of basin); and eastern, 39.2° (Station P-10-6, "deep hole" southeast of Long Point).

A typical bathythermograph recording from each basin shows that the central and eastern basins were thermally stratified (fig. 6). Thermoclines were generally found to be somewhat less inclined in the central basin than in the eastern basin. Secondary thermoclines were also indicated in the "deep hole." The areal extent of the stratified water is shown in figure 7 along with depths to the midpoints of the thermoclinal zones (metalimnion). It is interesting to note that in the central basin the thermocline appeared to have been several tens of feet closer to the surface off the north shore than along the south shore. This phenomenon is illustrated in figure 8 by a series of temperature profiles across the basin from Fairport, Ohio, to Port Stanley, Ontario. In this reach of 50 miles, the elevation of the thermocline rose 35 feet while the thermocline temperatures agreed within 2.5°F for the entire reach.

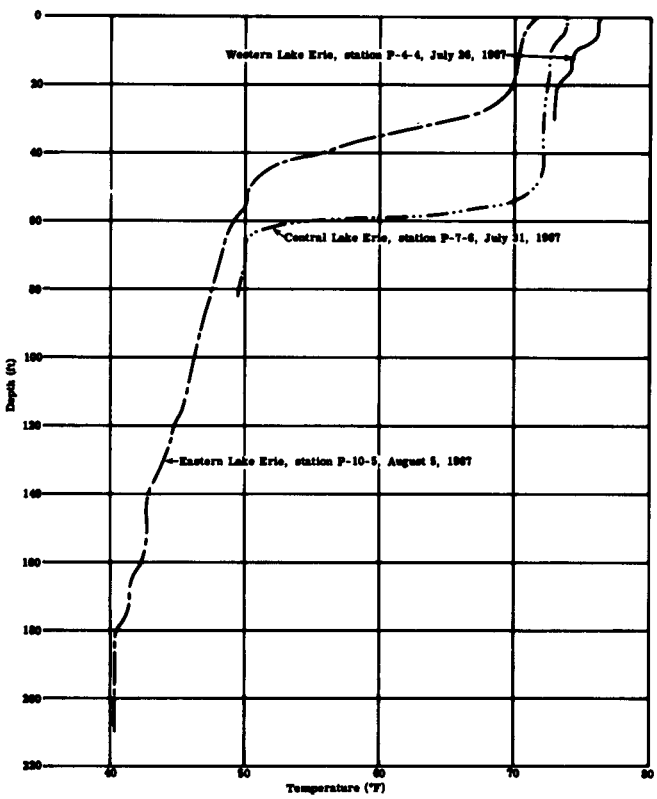


FIGURE 6.—Bathythermograph temperature recordings in the western, central, and eastern basins of Lake Erie.

Figures 9 through 14 are temperature and conductivity cross sections drawn from profile measurements. The following discussion will include mention of both of these properties, but more details on the significance of conductivity will be given under "Specific conductance."

The cross section along profile line 3 (fig. 9), near the mouth of the Detroit River, shows cooler water from midchannel flow entering western Lake Erie in the vicinity of Stations P-3-3 and P-3-4. The east and west side flows were considerably warmer and showed a sharp increase in ionized material, particularly on the Michigan side.

The cross section along profile line 5 (fig. 10), from Oxley, Ontario, to Catawba Island, Ohio, illustrates the nearly isothermal water of the western basin. Slightly cooler and less conductive water at Station P-5-4 presumably represented the easterly branch of the midchannel Detroit River flow.

This flow was again represented in the cross section along profile line 6 (fig. 11), from Pelee Point, Ontario, to Huron, Ohio, after the water had entered the central basin through Pelee Passage. Thermal stratification is also shown in this cross section, with a thermocline uptilted toward the north. Apparently the rise in the thermocline resulted from an upwelling of cold hypolimnion water along the north shore. The conductivity contours show higher values toward the bottom, probably due in part to solutioning of the sediments.

The cross section along profile line 8 (fig. 12), from Port Stanley, Ontario, to Fairport, Ohio, demonstrates the typical temperature structure that was found in the central basin. As already shown in figure 8, the thermocline was considerably shallower near the north shore. Conductivity readings were highest near the shore and in the lower part of the hypolimnion. Epilimnion water, except for a narrow zone near the south shore, appeared to be very uniform and relatively low in dissolved solids.

The cross section along profile line 10 (fig. 13), from Port Dover, Ontario, to Erie, Pennsylvania, shows the temperature structure in the deepest part of Lake

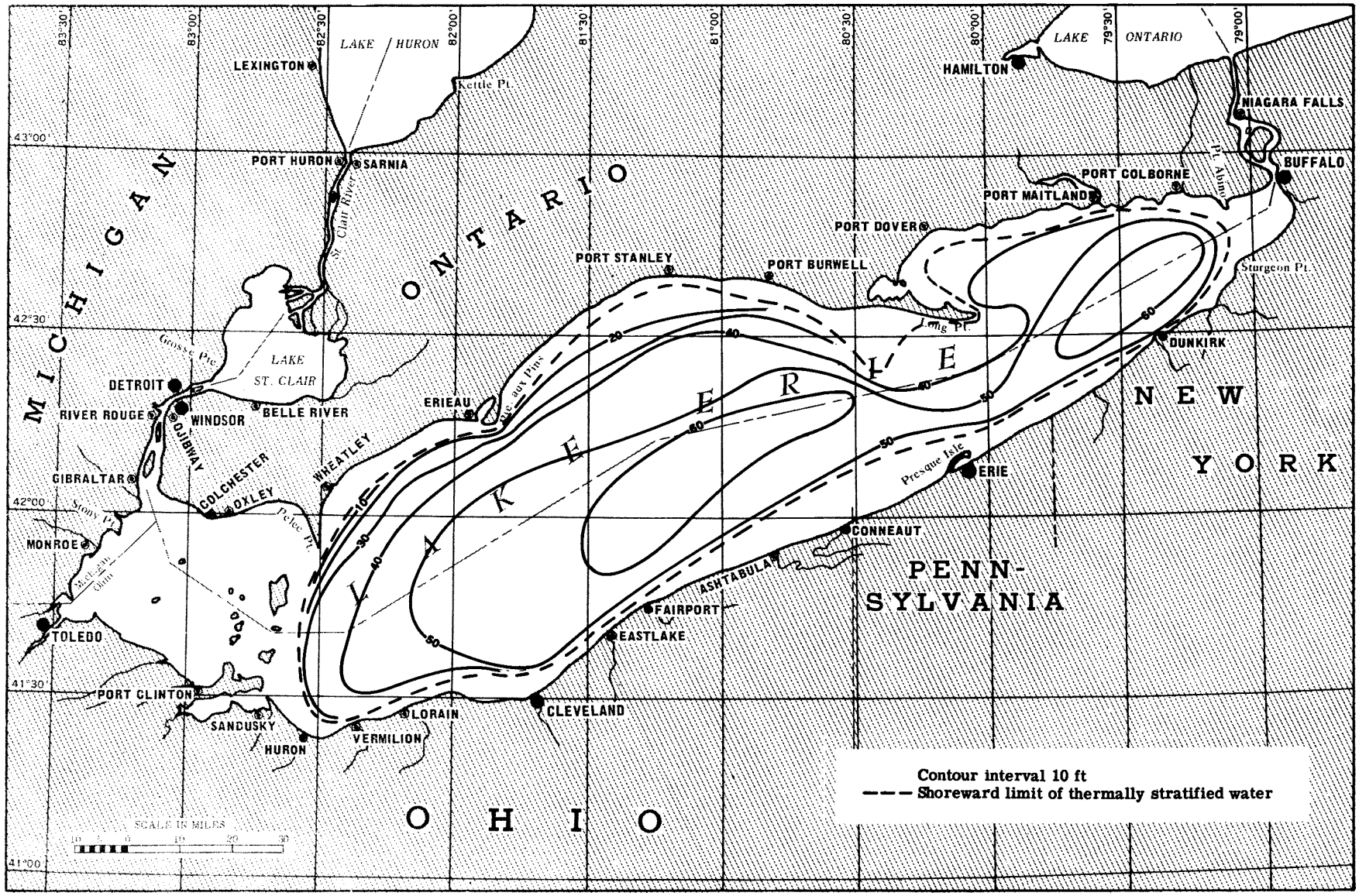


FIGURE 7.—Areal extent of thermally stratified water in Lake Erie, showing depths to midpoints of thermocline zones.

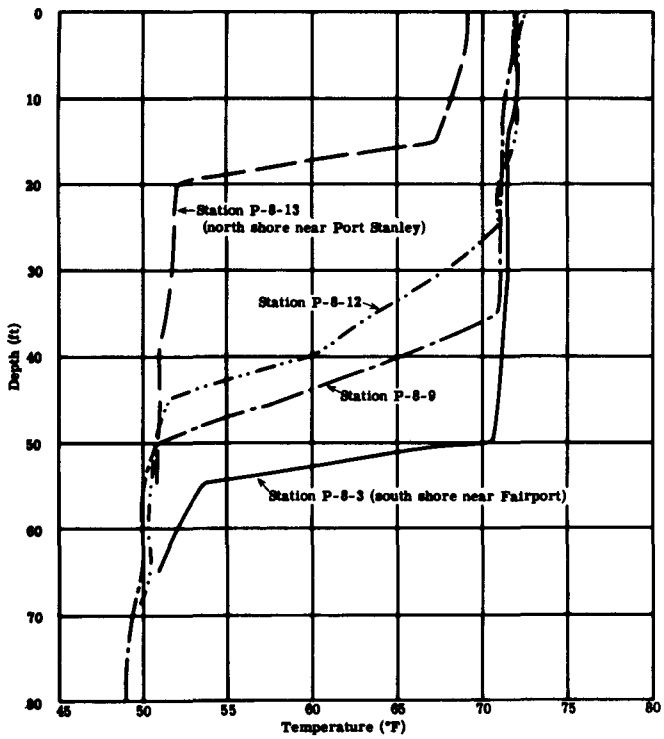


FIGURE 8.—Thermocline variation from north to south shore of central Lake Erie.

Erie. The thermocline in the "deep hole" was at about 40 feet, a relatively shallow depth for the deepness of the basin, and probably here also due to upwelling. This upwelling, however, does not seem to have been as active as in the central basin. Conductivity readings showed a moderate increase in ionized material below the thermocline.

The cross section along profile line 11 (fig. 14) is typical of the temperature and conductivity structure that was present in the eastern basin. The upwelling along the north shore was not nearly as pronounced as in the central basin. Conductivity values increased by approximately 10 percent from surface to bottom water. Nearshore conductivity values were only slightly higher than midlake readings.

Specific conductance.—Specific conductance (conductivity) of water is a measurement of the capacity of the water to convey an electrical current, and is generally expressed in micromhos/cm at a temperature of 25°C. This property is related to the concentration of dissolved substances in the water and to its temperature. The conductivity of a particular sample depends on the nature of the ions present; therefore, no universal relationship can be determined for the ratio

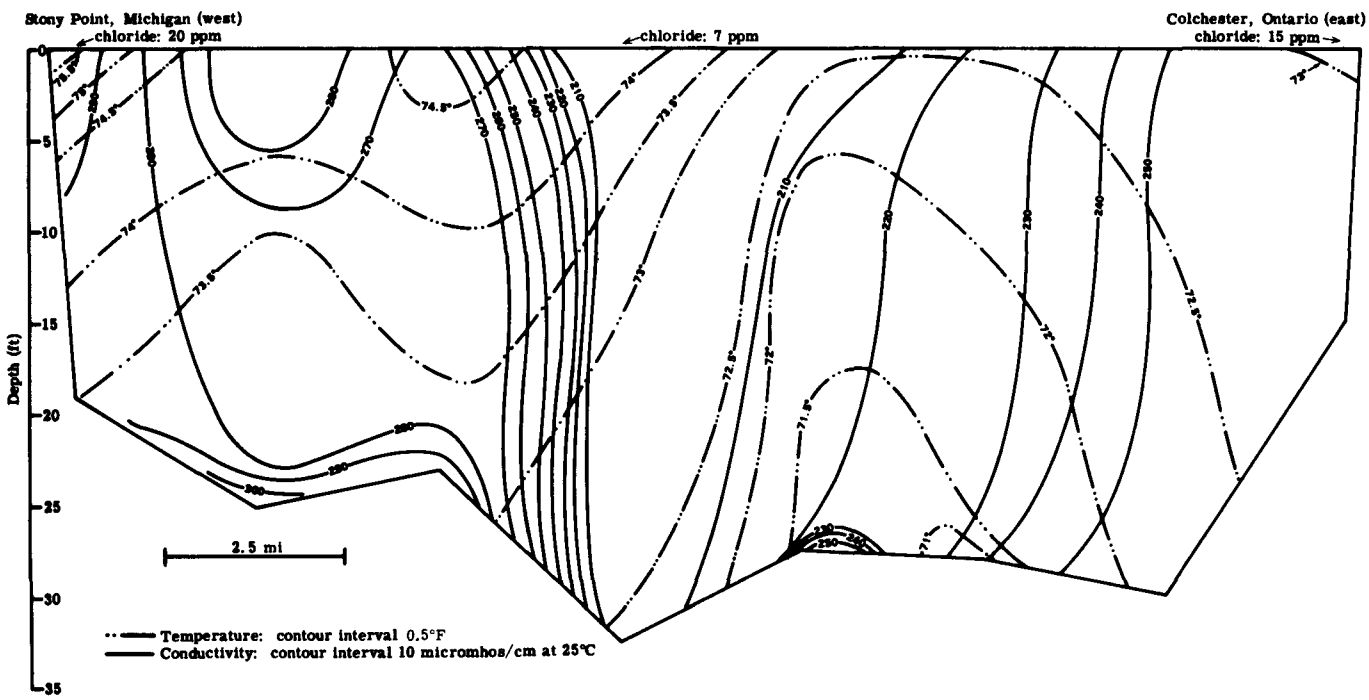


FIGURE 9.—Generalized temperature and conductivity cross section in western Lake Erie: Stony Point, Michigan, to Colchester, Ontario.

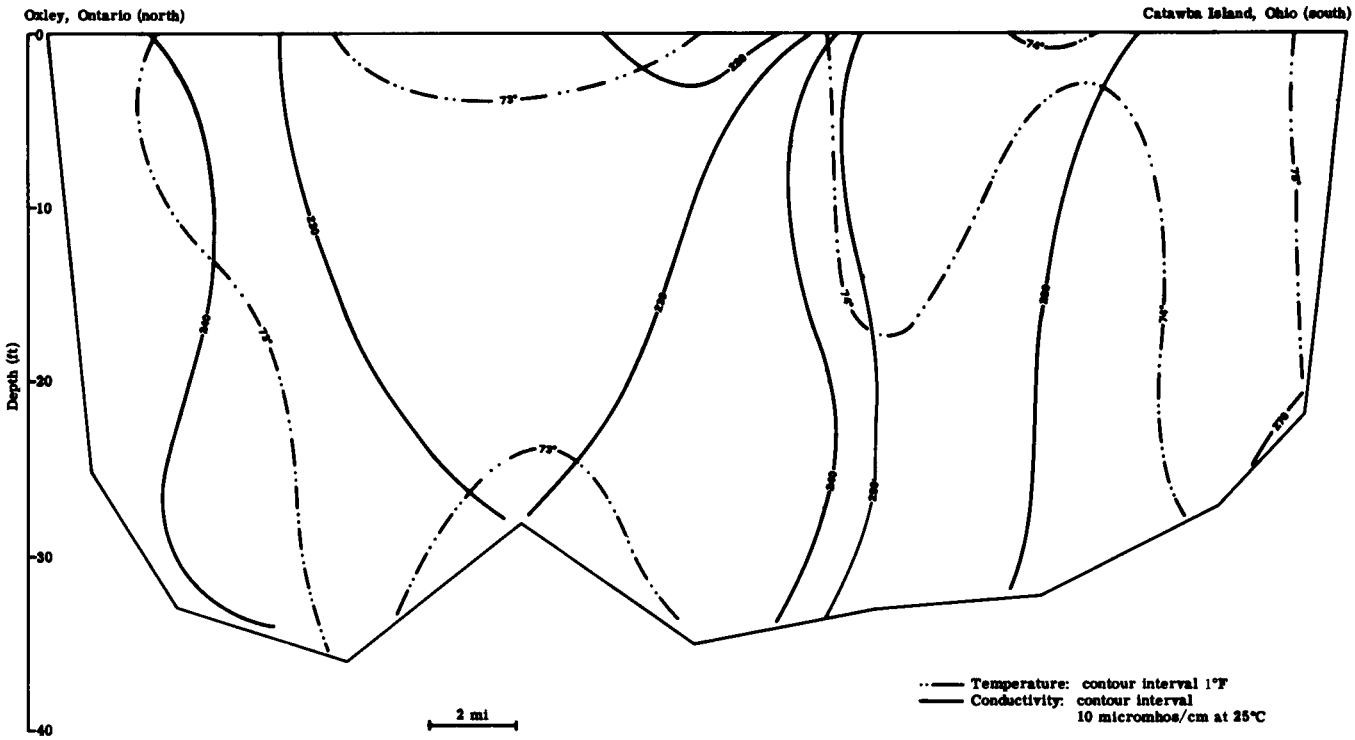


FIGURE 10.—Generalized temperature and conductivity cross section in western Lake Erie: Oxley, Ontario, to Catawba Island, Ohio.

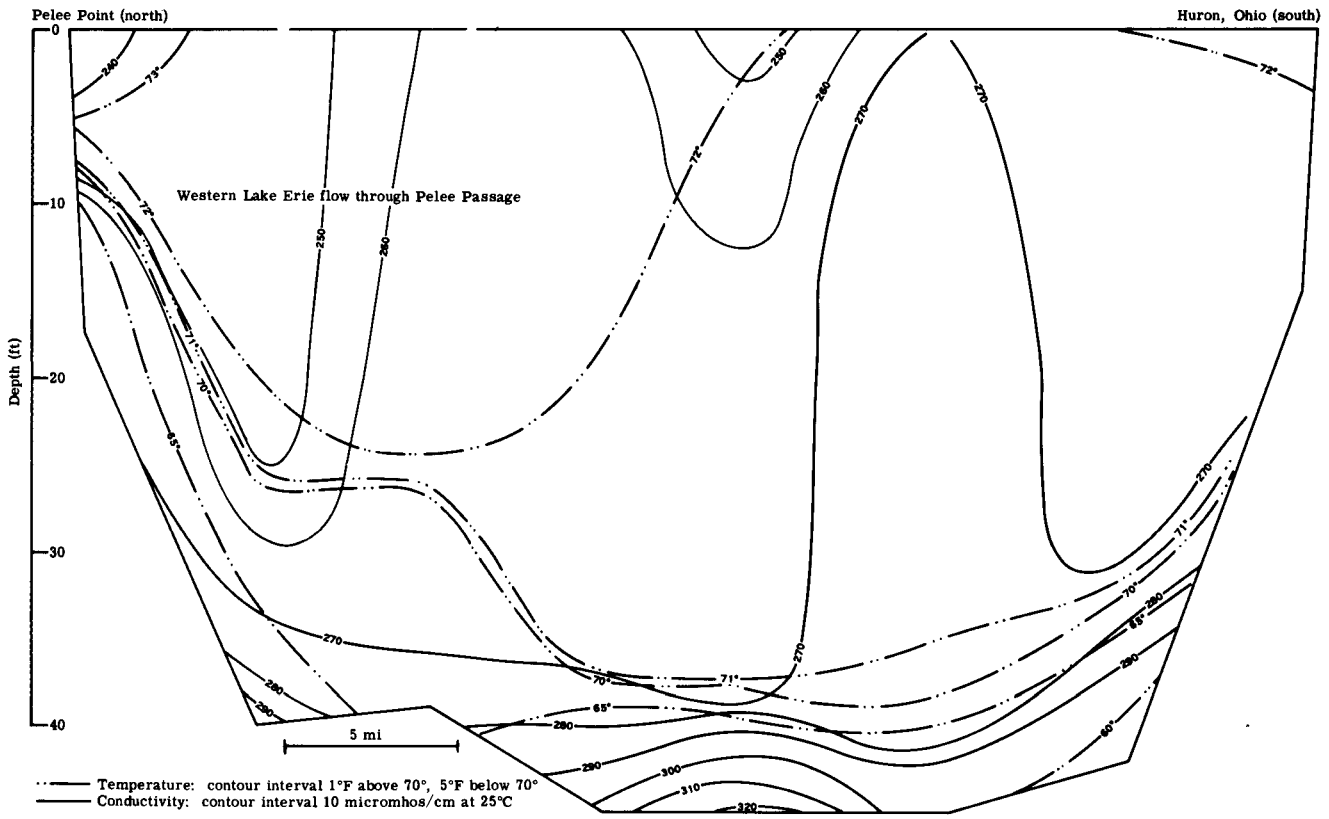


FIGURE 11.—Generalized temperature and conductivity cross section in central Lake Erie: Pelee Point, Ontario, to Huron, Ohio.

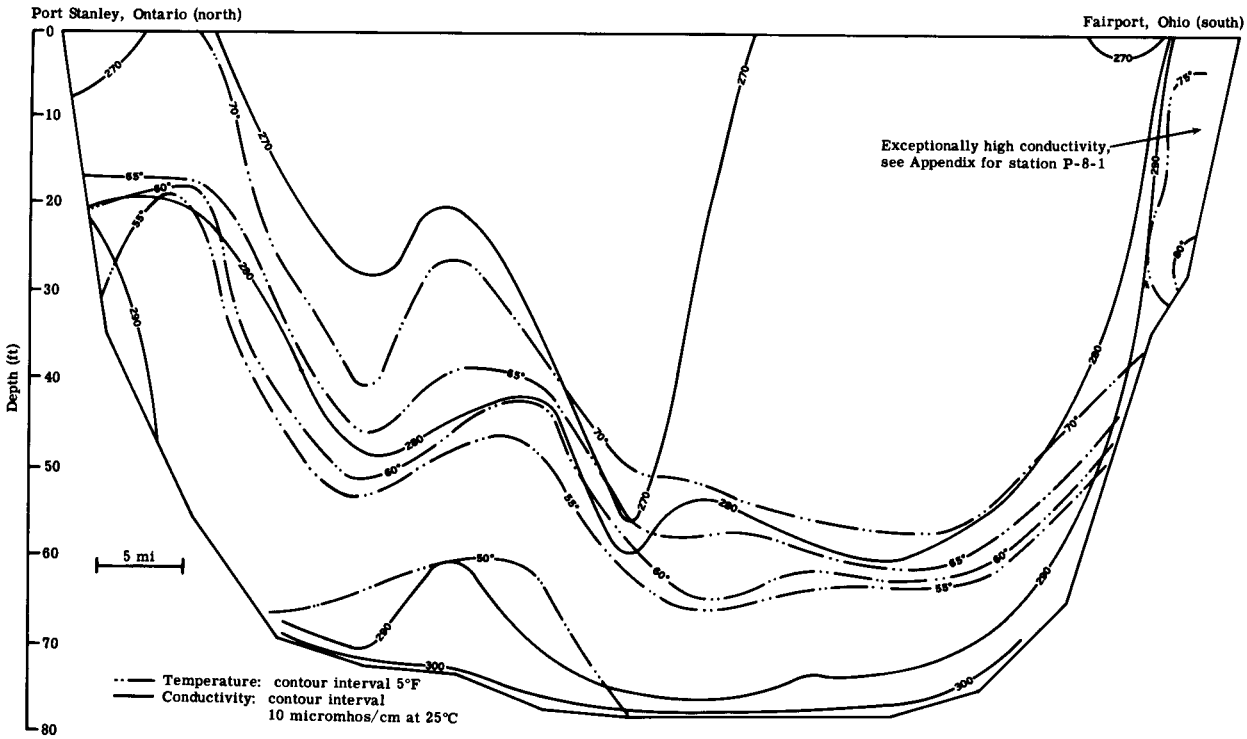


FIGURE 12.—Generalized temperature and conductivity cross section in central Lake Erie: Port Stanley, Ontario, to Fairport, Ohio.

of specific conductance (SC) to total dissolved solids (TDS). For a particular body of water, such as Lake Erie, the correlation determined from a large number of samples can provide a convenient index of the total ionic concentration. Calculations on data from 16 water intakes along the south shore of Lake Erie yielded a figure of 0.58 for TDS/SC; the ratio for 16 south shore streams tributary to the lake was 0.65. Both calculations are based on 1950 to 1952 data from the U.S. Geological Survey. Midlake data from 1963 and 1964 studies by the Federal Water Pollution Control Administration showed that the TDS/SC value was 0.60 for the western basin and 0.59 for the central and eastern basins.

Profile measurements of specific conductance were made at each station. These data are summarized in table 3. The average conductivity for Lake Erie was 275 micromhos/cm. A marked increase from west to east was noted during the cruise: Lake St. Clair, 206; Detroit River, 247; western basin, 246; central basin, 278; eastern basin, 287; and Niagara River, 289. Bottom water consistently had higher specific conductance readings than surface water. The average surface to bottom increase for the entire lake was 32 micromhos/cm; by basins it was: western, 25; central, 42; and eastern, 17.

The distribution of specific conductance in the surface water of the lake is shown in figure 15 and in the bottom water in figure 16.

The surface and bottom conductivity patterns demonstrate the influence of midchannel Detroit River flow on water movement in the western basin. Surface readings on the west side of the Detroit River were the highest in the western basin. Surface conductivity readings in the deeper basins were fairly uniform except for a marked increase near the Ohio shore in the southeastern part of the central basin. The highest conductivity readings of bottom water, with the exception of measurements in harbor water, were taken in the south-central part of the central basin.

Figures 9 through 14 show conductivity along several cross sections which are discussed under the preceding heading, "Temperature."

Water color and transparency.—Water color was estimated visually at all stations and the distribution of colors is shown in figure 17. The Detroit River showed a midchannel flow of cloudy green water flanked by turbid brownish-green water along the east and west shores. From the west side the brownish-green water extended southward along the Michigan shore to Maumee Bay. The central part of the western basin contained moderately clear green water fringed by more cloudy water near the shore. Most of the central and eastern basins water appeared clear and dark green. A

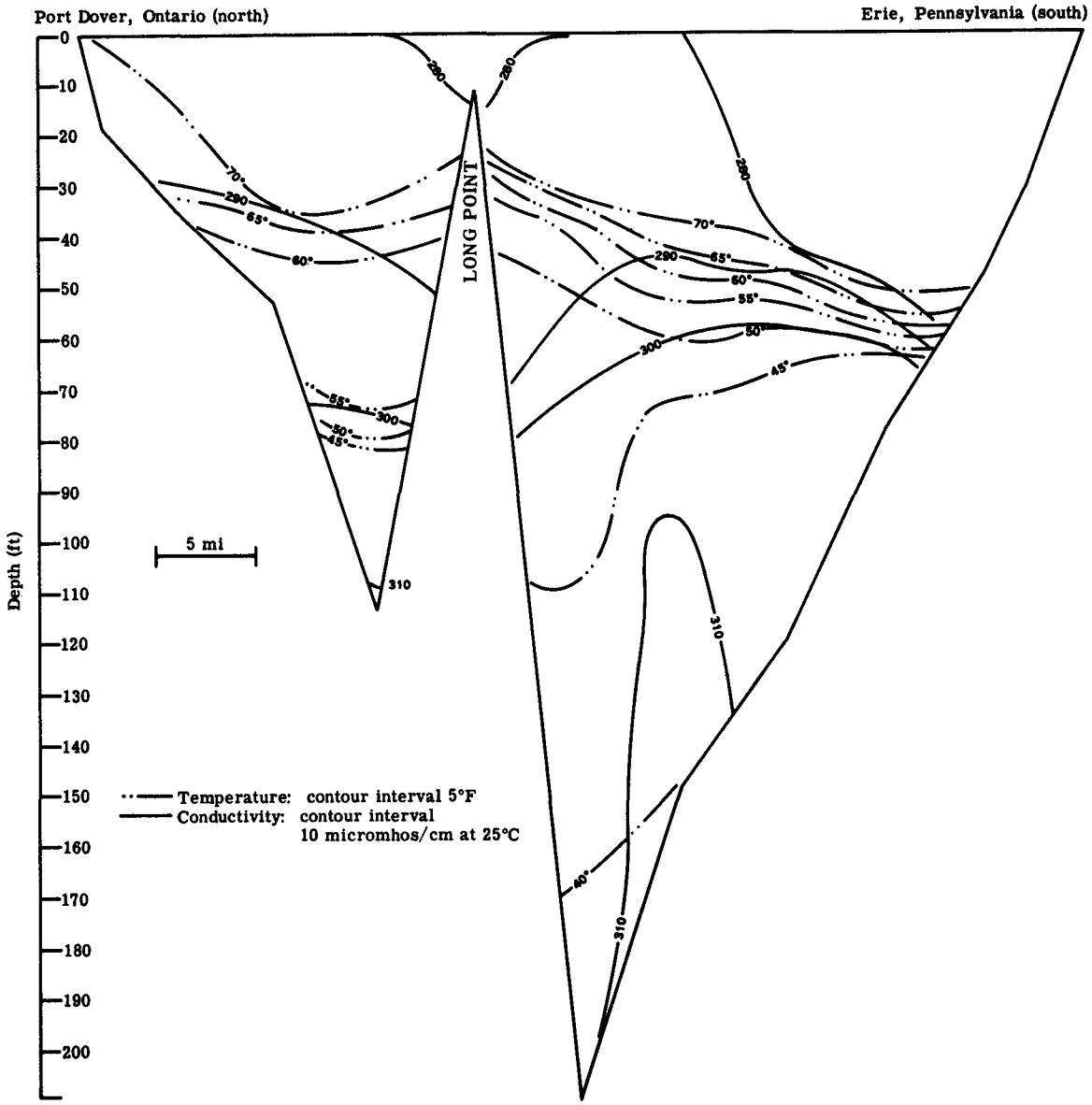


FIGURE 13.—Generalized temperature and conductivity cross section in eastern Lake Erie: Port Dover, Ontario, to Erie, Pennsylvania.

several-mile-wide band of moderately clear grayish- or brownish-green water characterized the southern shore, but the clear dark-green water extended to within a short distance of the north shore.

Water transparency as measured by Secchi disc shows a general increase in transparency from west to east (table 4 and fig. 18). The maximum transparency readings by basin were: western, 10.8 feet; central, 27.5 feet; and eastern, 30.0 feet. Readings from mid-channel Detroit River flow were 3 to 4 feet higher than those from the flanking east and west flows. The clearest water in the western basin (Station P-5-2) appears to have been the result of an influx of central basin water through Pelee Passage. In the central basin,

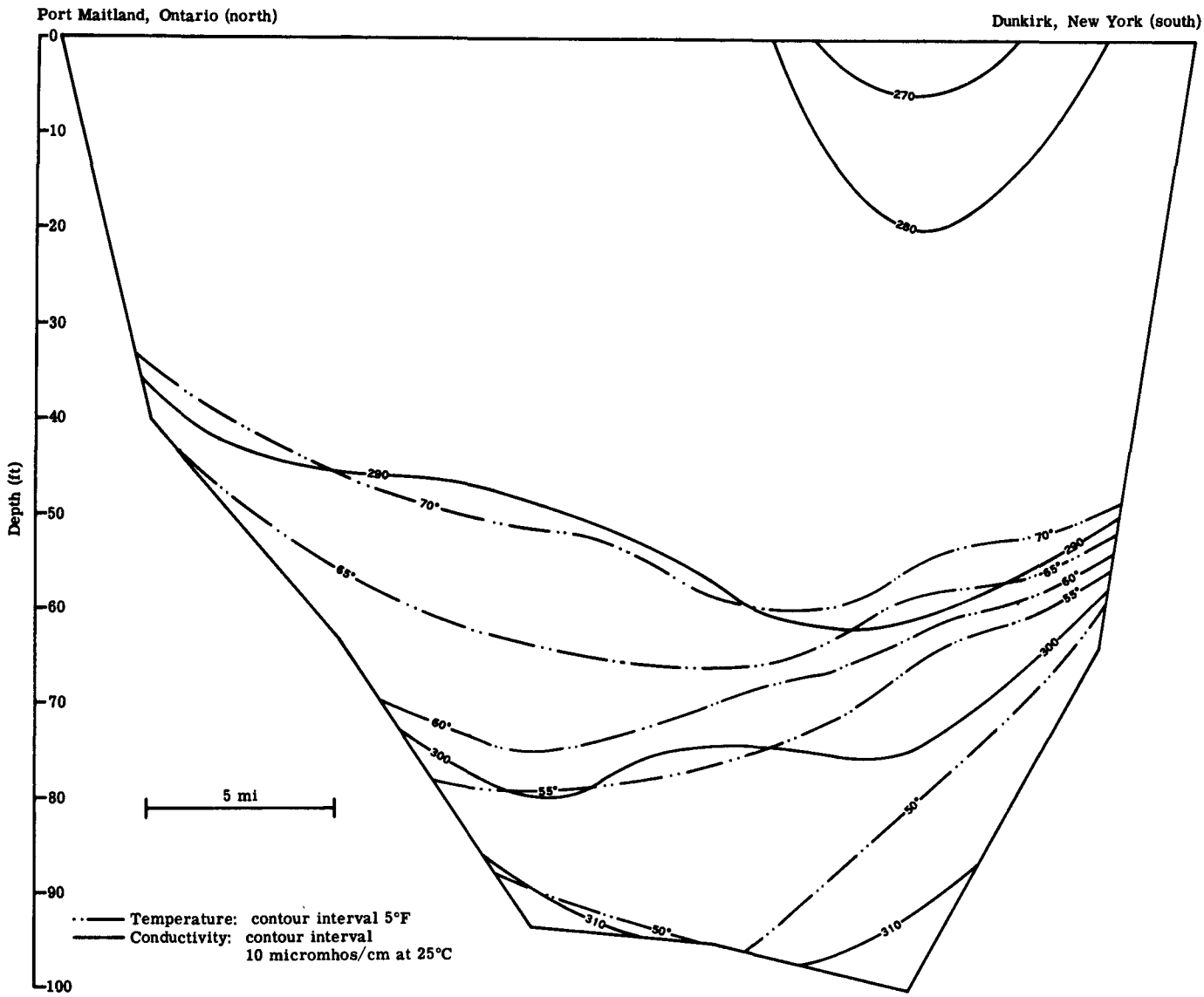


FIGURE 14.—Generalized temperature and conductivity cross section in eastern Lake Erie: Port Maitland, Ontario, to Dunkirk, New York.

the highest readings were near the center of the basin. Unexpectedly, the southern half of the basin yielded somewhat higher readings than the northern half, although a considerably steeper transparency gradient was found along the south shore (fig. 18). Over two-thirds of the eastern basin had transparency readings greater than 20 feet and water clarity decreased from the western end to the eastern end of the basin.

Hydrogen-ion concentration (pH).—The pH measurements made during the cruise are summarized in table 5. In general, the measurements show that pH was slightly higher in the western basin than in the central and eastern basins, which had nearly identical values, and that throughout the lake the average surface pH exceeded that of the bottom by about 0.2 unit. The average pH of Lake Erie water was found to be 8.3.

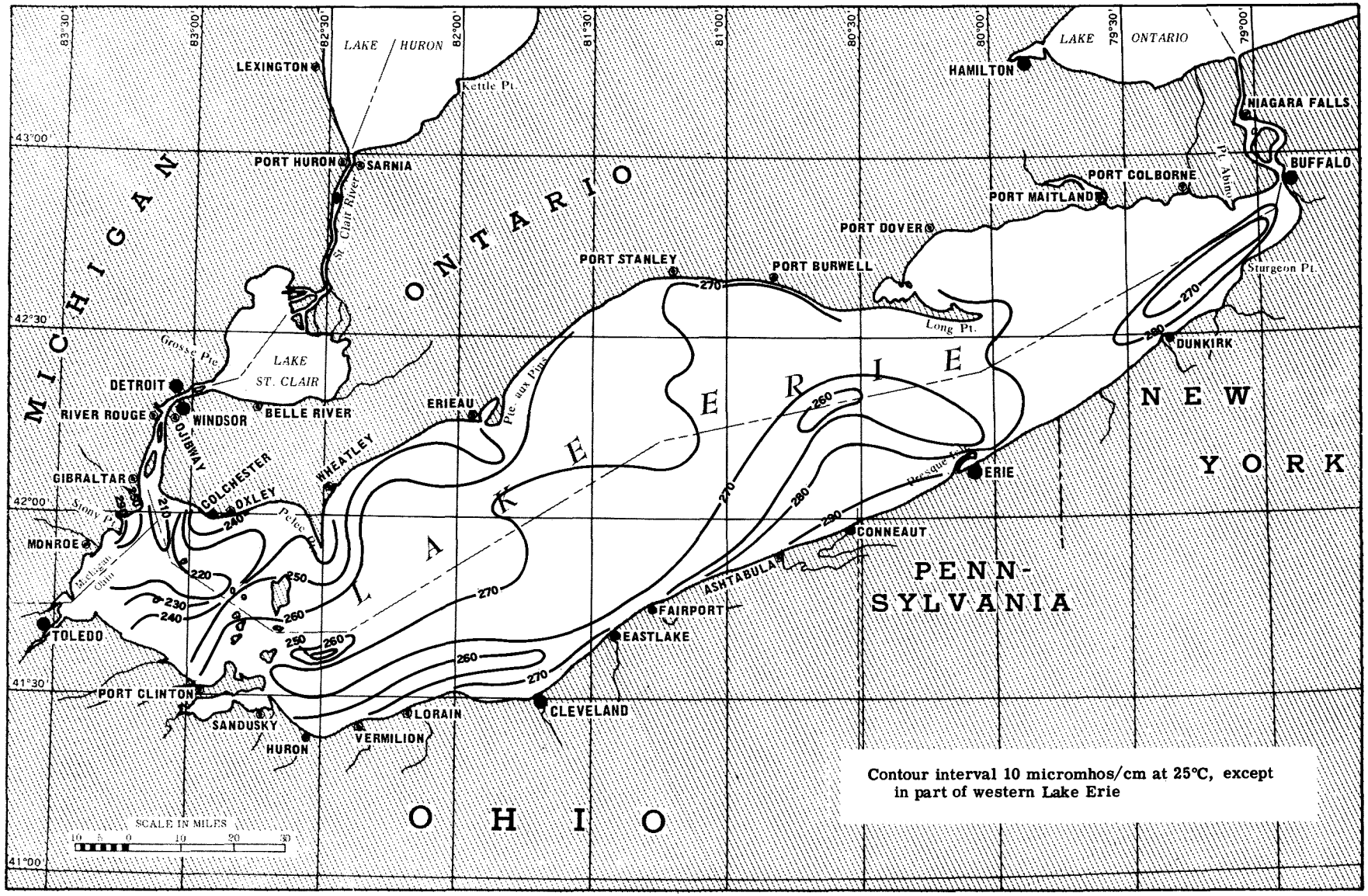


FIGURE 15.—Specific conductance of Lake Erie surface water.

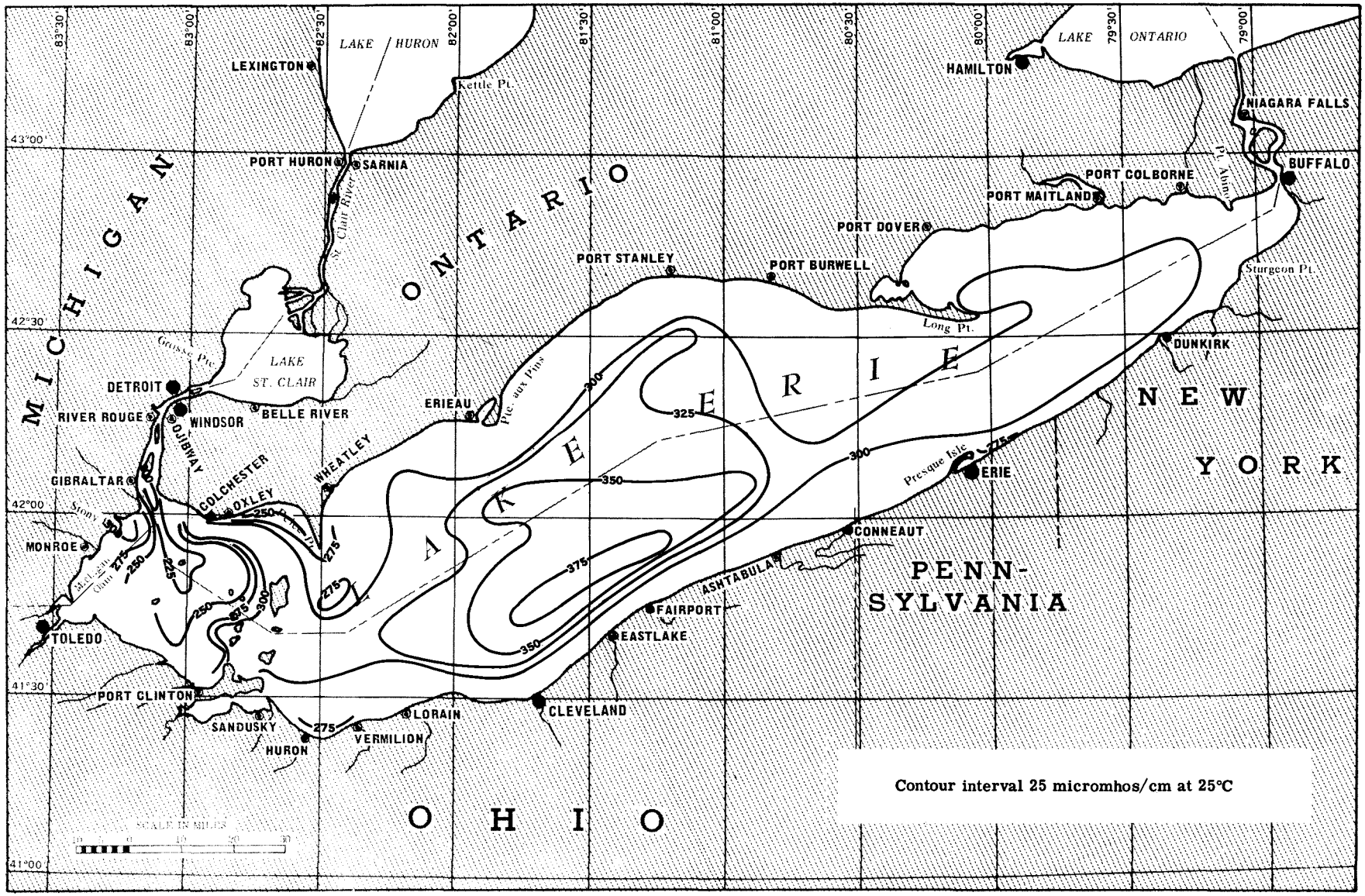


FIGURE 16.–Specific conductance of Lake Erie bottom water.

TABLE 3.—*Lake Erie conductivity survey*

Profile line or lake area	All measurements		Surface measurements		Bottom measurements	
	Number of readings	Average conductivity (micromhos/cm at 25°C)	Number of readings	Average conductivity (micromhos/cm at 25°C)	Number of readings	Average conductivity (micromhos/cm at 25°C)
P-1	46	206				
P-2	27	247				
P-3	61	247				
P-4	55	242				
P-5	76	249				
P-6	138	268				
P-7*	193	279				
P-8*	203	280				
P-9	155	281				
P-10	171	288				
P-11	105	286				
P-12	34	282				
P-13	3	289				
Lake Erie and connecting waterways	1,267	272	110	270	102	291
Lake Erie	1,191	275	95	264	93	296
Western basin	192	246	25	242	25	267
Central basin	689	278	50	269	48	311
Eastern basin	310	287	20	279	20	296

* Exceptionally high readings in Cleveland and Fairport harbors excluded.

Figures 19 and 20 show the distribution of hydrogen-ion concentration in the surface and bottom waters of Lake Erie. The surface pattern of pH values (fig. 19) points out the strong influence of midchannel Detroit River flow on water circulation in western Lake Erie. This flow appeared to branch once it entered the western basin, with a wedge that moved southward toward the Ohio shore and another that flowed eastward through Pelee Passage. Higher values of flanking flows, particularly that along the Michigan and Ohio shore, appeared to be associated with abundant algae growth where the water was supersaturated with dissolved oxygen (fig. 22). Surface water in the central and eastern basins was fairly uniform in hydrogen-ion concentrations. The lowest values were found along the shorelines while the areas of highest concentration occurred near the centers of the basins.

The bottom water pH pattern for the western basin (fig. 20) was similar to that of the surface water. The central and eastern basin values, however, were in reverse order from the surface readings, with the lowest readings near the centers of the basins and highest values near the shores. Two centers of low pH were found, one between Erieau and Cleveland and the other in the eastern basin in the vicinity of the "deep hole." The measurement made at the bottom of the "deep hole" (Station P-10-6) was the only one taken during the cruise that indicated an acid pH. The lower pH readings in the deeper areas of the central and eastern basins may be related to cation exchange in the clay sediments (Kramer, 1961).

Dissolved oxygen content (DO).—The dissolved oxygen content of water samples was measured at the surface at 53 stations and at the bottom at 45 stations. The results of these measurements are summarized by profile line and basin in table 6. The depth, water temperature, and percent oxygen saturation of each sample are shown in table 7. The distribution of dissolved oxygen and percent oxygen saturation of surface and bottom waters of Lake Erie are illustrated in figures 21 through 24.

Surface water throughout the lake averaged 9.0 ppm dissolved oxygen and bottom water 6.8 ppm. The difference between the average surface and average bottom DO concentrations of the three basins varied considerably: western basin, 1.2 ppm; central basin, 3.8 ppm; and eastern basin, 0.8 ppm. The central basin, with an average DO of 5.4 ppm for bottom water, had the lowest concentration.

Surface water was fairly uniform in dissolved oxygen concentration, with all but 5 samples measuring between 8 and 10 ppm. Higher concentrations in the

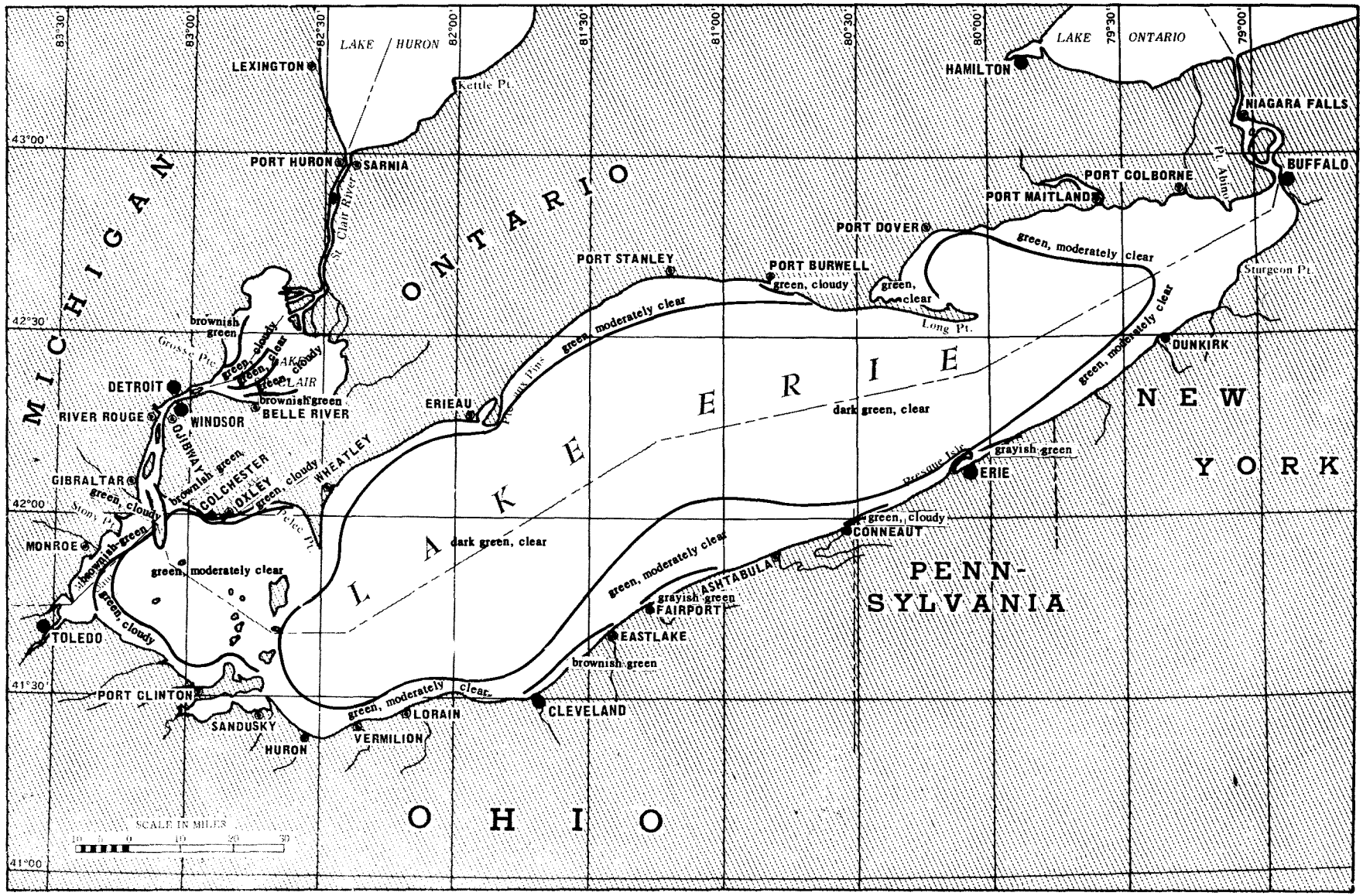


FIGURE 17.—Distribution of Lake Erie water color.

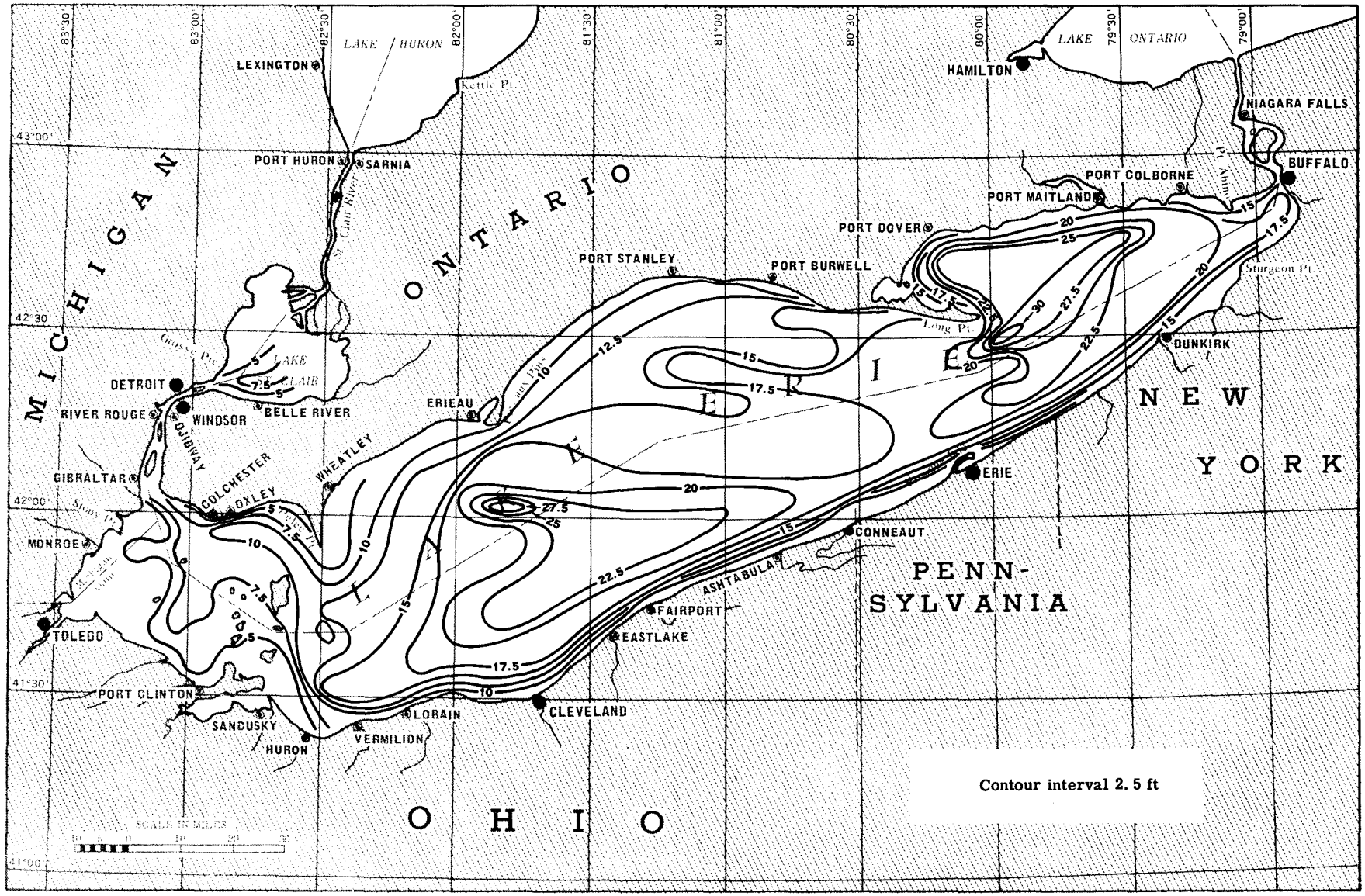


FIGURE 18.—Distribution of Lake Erie water transparency by Secchi disc.

TABLE 4.—*Lake Erie transparency summary*

Profile line or lake area	Number of readings	Average transparency (ft)
P-1	6	4.6
P-2	3	3.3
P-3	8	4.9
P-4	8	5.2
P-5	9	6.4
P-6	10	10.0
P-7	14	17.0
P-8	13	16.4
P-9	12	13.1
P-10	10	21.0
P-11	6	21.3
P-12	3	16.7
P-13	--	--
Lake Erie and connecting waterways	102	12.5
Lake Erie	93	13.3
Western basin	25	5.6
Central basin	49	14.5
Eastern basin	19	20.5

western basin, where supersaturations as high as 140 percent were found, were probably caused by the abundance of phytoplankton. Surface saturations for the remainder of the lake normally ranged from 90 to 110 percent.

Dissolved oxygen in the bottom water of the western and eastern basins ranged from 6 to 9.5 ppm, indicating an orthograde distribution. Most of the central basin exhibited distinct clinograde oxygen distribution with bottom levels as low as 1.5 ppm (about 15 percent saturation). Nearly half of the area of the central basin showed 5 ppm or less DO in the hypolimnion. The most critical areas of low oxygen were found in the southwestern sector of the basin, with fingerlike projections extending northward toward the Ontario shore and northeastward toward the central part of the basin. In contrast, dissolved oxygen content at the bottom of the "deep hole" of the eastern basin was 9.0 ppm (about 70 percent saturation).

Chloride-ion concentration.—Chloride-ion concentration measurements were made on 51 surface samples, 36 bottom samples, and 2 midwater samples. The results of these analyses are summarized in table 8 and mapped in figures 25 and 26. The average reading was

TABLE 5.—*Lake Erie hydrogen-ion (pH) summary*

Profile line or lake area	All measurements		Surface measurements		Bottom measurements	
	Number of readings	Average pH	Number of readings	Average pH	Number of readings	Average pH
P-1	6	8.4				
P-2	3	8.4				
P-3	6	8.4				
P-4	6	8.6				
P-5	14	8.3				
P-6	13	8.3				
P-7	10	8.3				
P-8	8	8.1				
P-9	8	8.3				
P-10	10	8.2				
P-11	6	8.2				
P-12	6	8.5				
P-13	3	8.2				
Lake Erie and connecting waterways	66	8.3	52	8.4	44	8.2
Lake Erie	87	8.3	44	8.4	42	8.2
Western basin	26	8.4	14	8.5	12	8.3
Central basin	39	8.3	19	8.4	19	8.1
Eastern basin	22	8.3	11	8.4	11	8.2

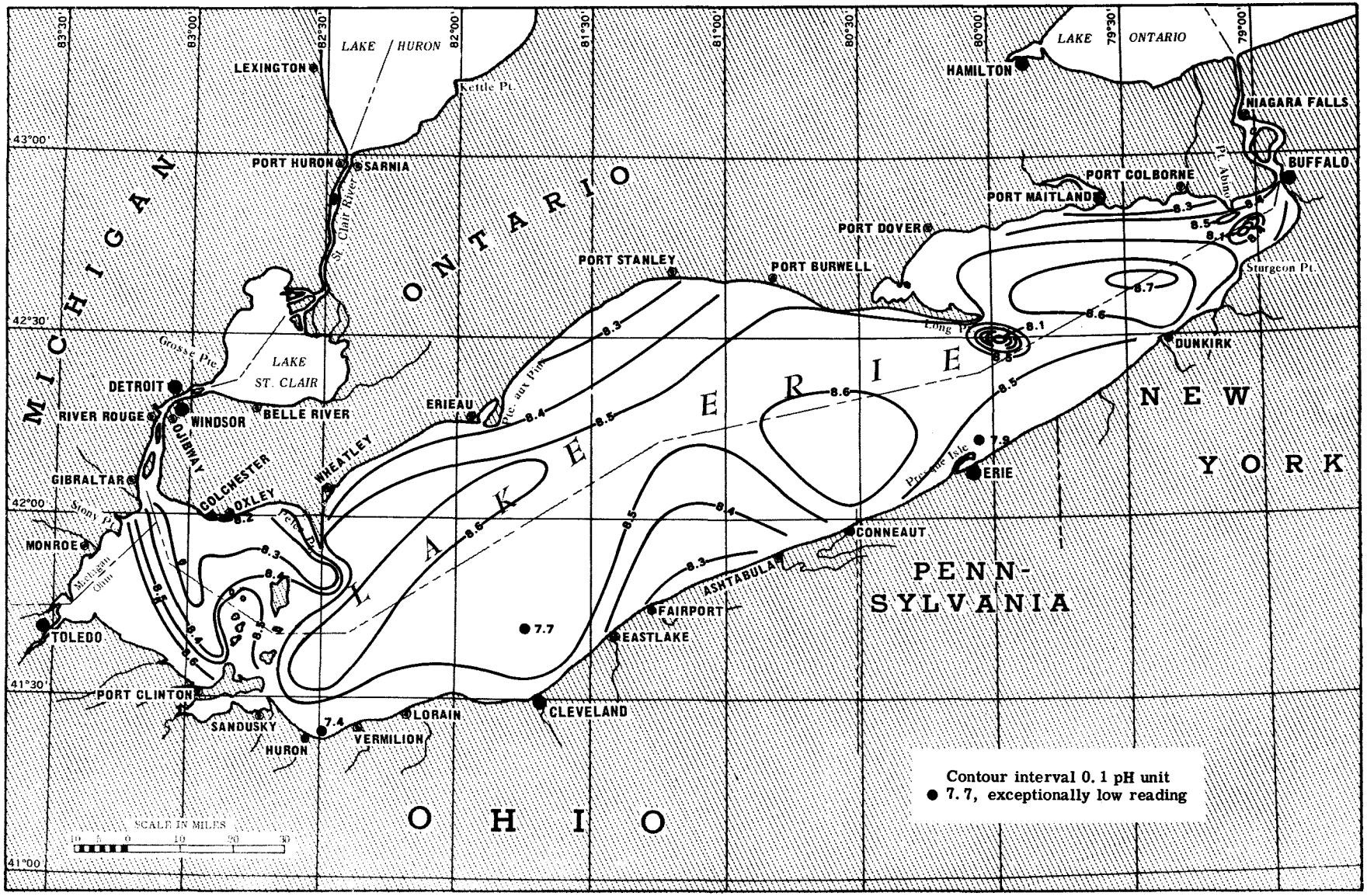


FIGURE 19.—Hydrogen-ion concentration (pH) in Lake Erie surface water.

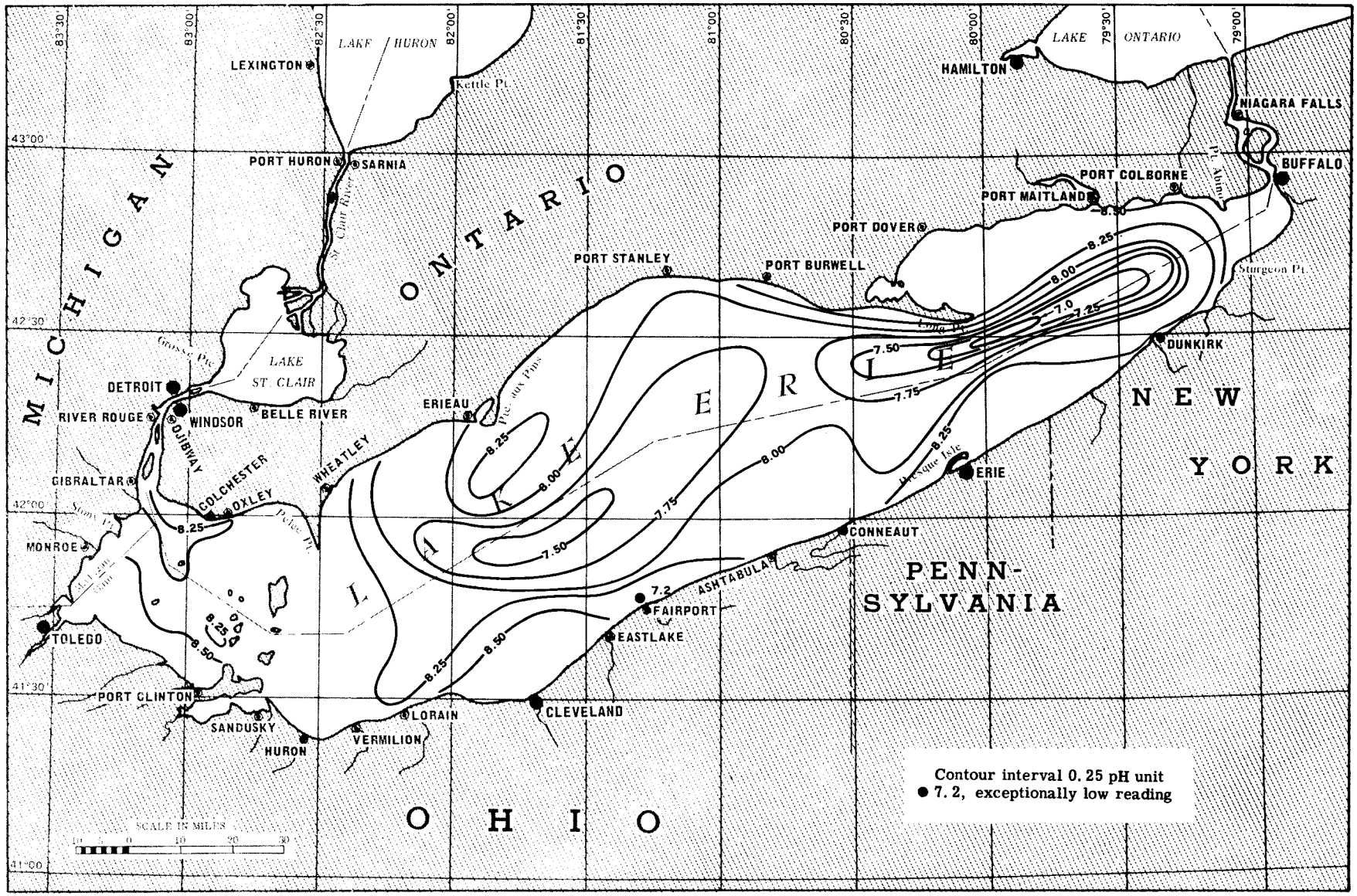


FIGURE 20.—Hydrogen-ion concentration (pH) in Lake Erie bottom water.

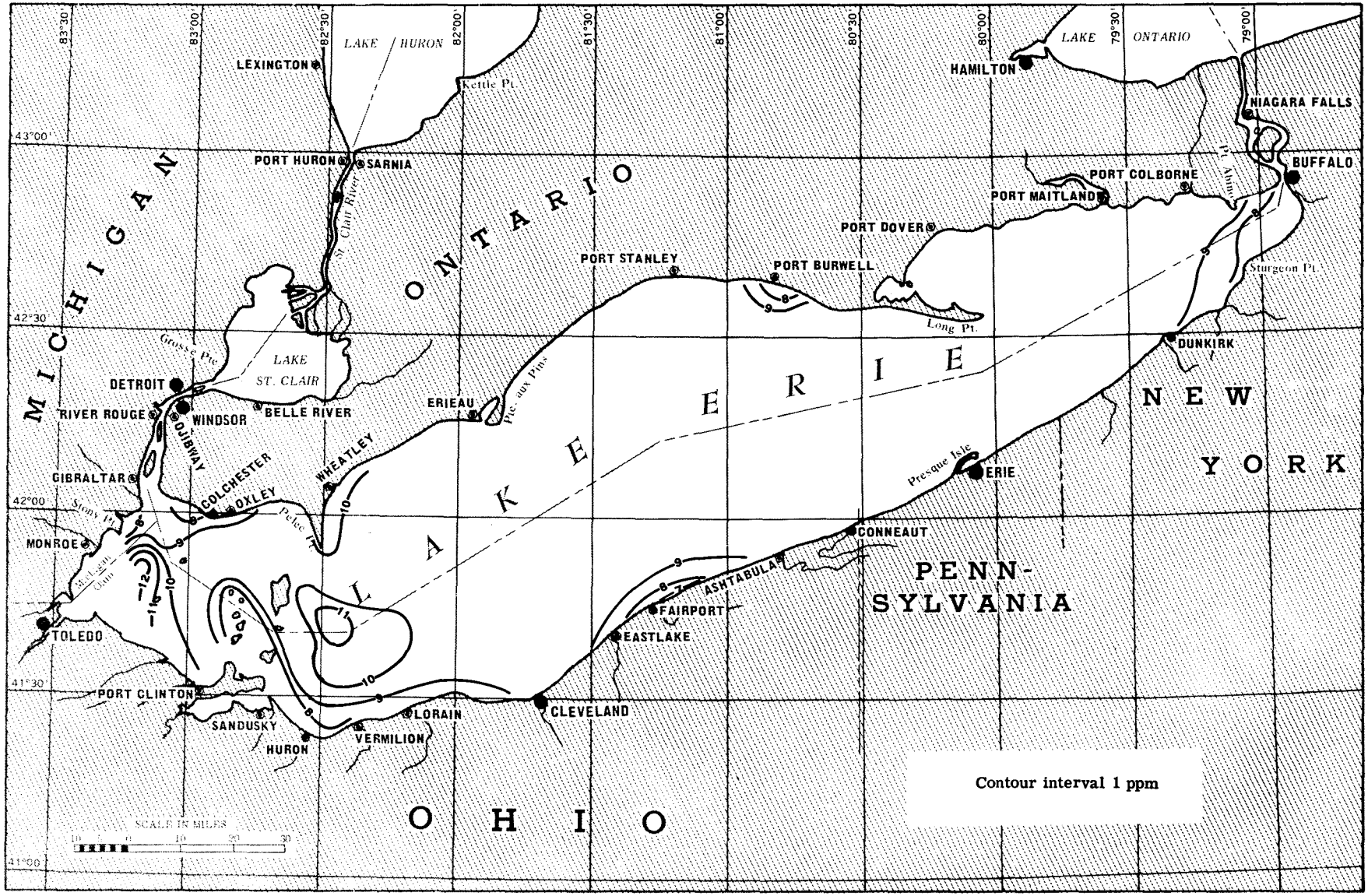


FIGURE 21.—Distribution of dissolved oxygen in Lake Erie surface water.

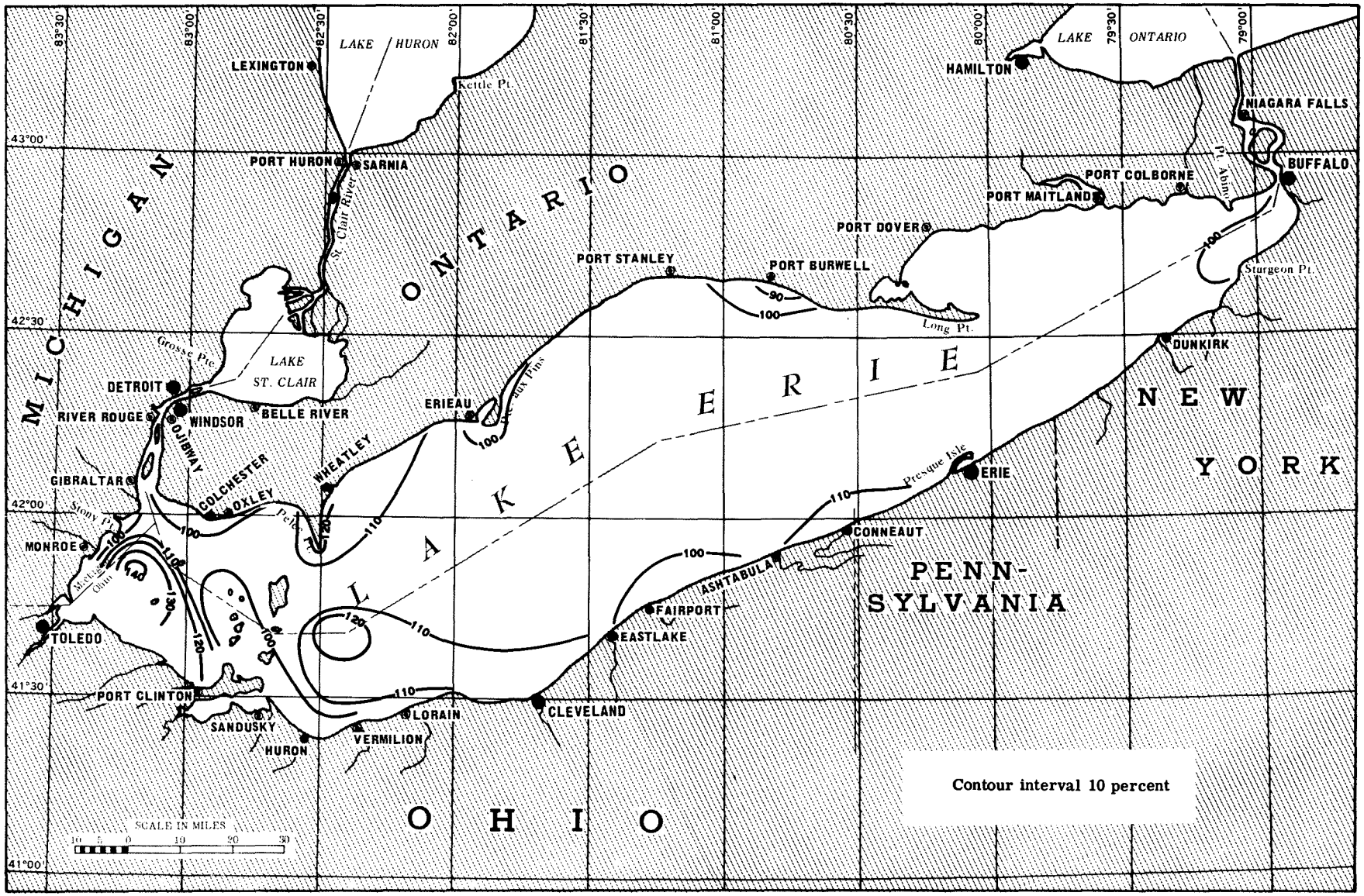


FIGURE 22.—Percent saturation of dissolved oxygen in Lake Erie surface water.

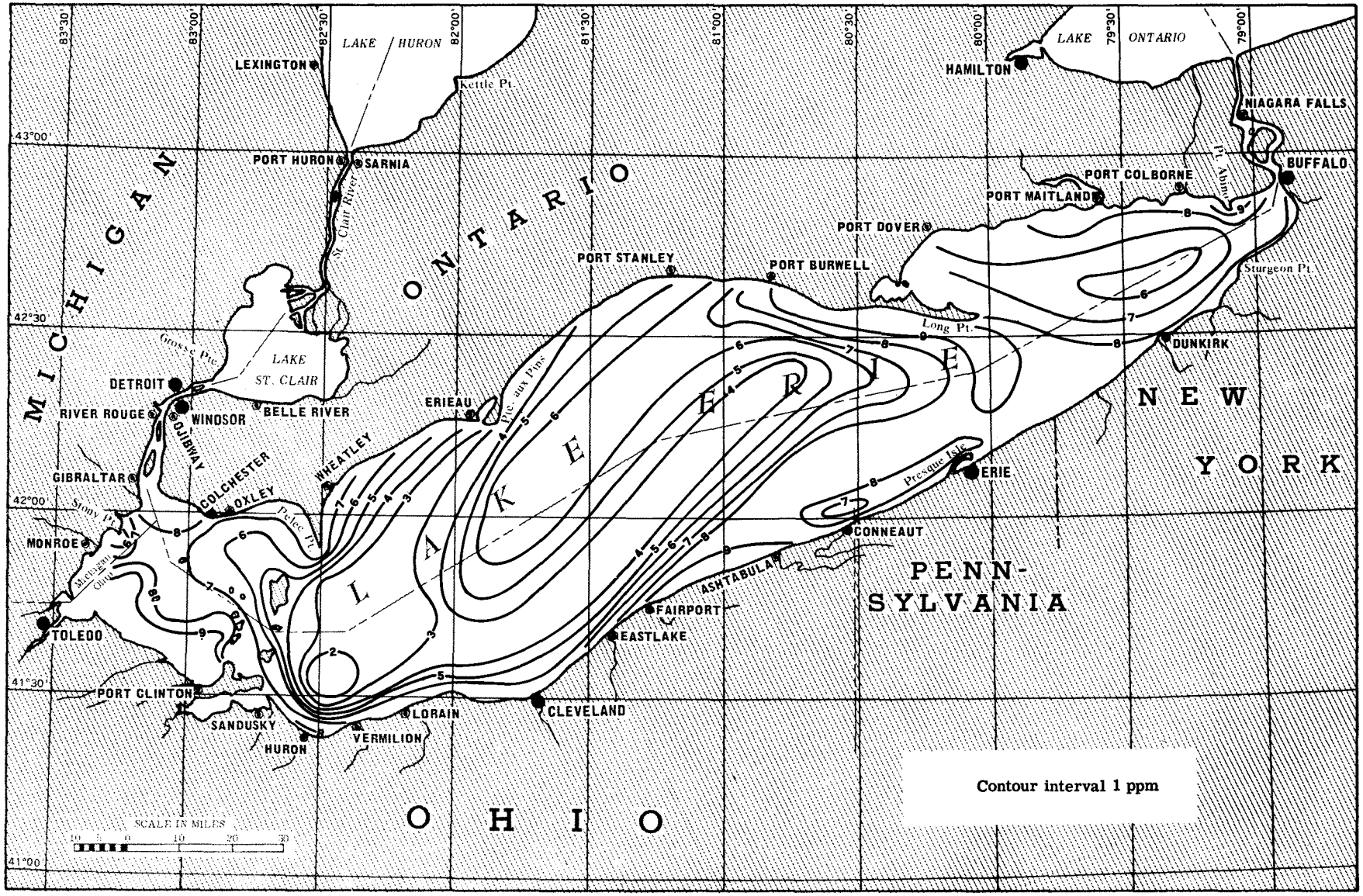


FIGURE 23.—Distribution of dissolved oxygen in Lake Erie bottom water.

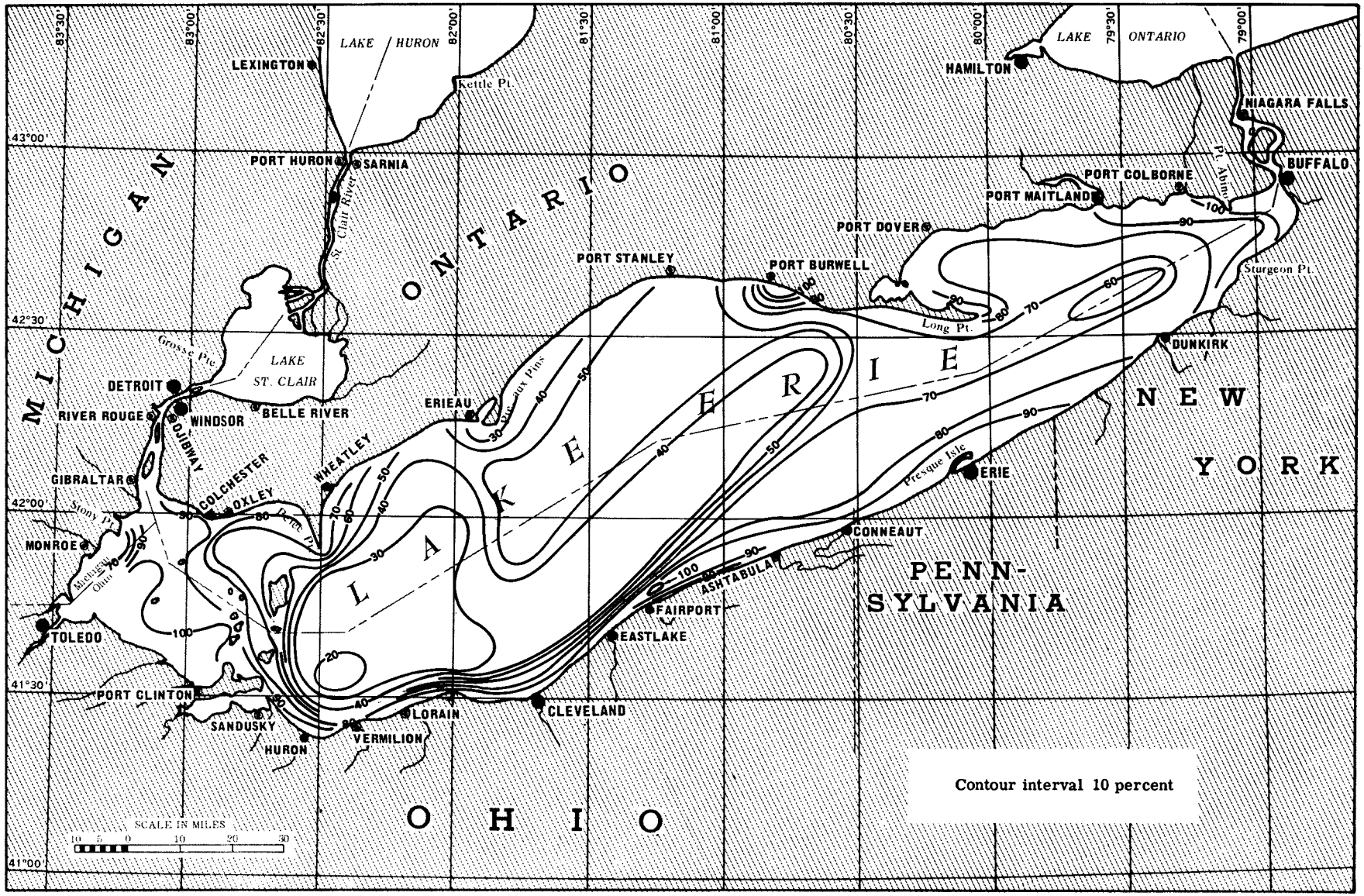


FIGURE 24.—Percent saturation of dissolved oxygen in Lake Erie bottom water.

TABLE 6.—*Lake Erie dissolved-oxygen summary*

Profile line or lake area	All measurements		Surface measurements		Bottom measurements	
	Number of readings	Average DO (ppm)	Number of readings	Average DO (ppm)	Number of readings	Average DO (ppm)
P-1	6	9.2				
P-2	3	9.6				
P-3	6	7.7				
P-4	6	10.0				
P-5	14	8.0				
P-6	13	6.5				
P-7	10	7.1				
P-8	10	7.4				
P-9	8	7.9				
P-10	10	8.6				
P-11	6	8.1				
P-12	6	8.2				
P-13	3	7.3				
Lake Erie and connecting waterways	101	8.0	53	9.0	45	6.9
Lake Erie	89	7.8	45	9.0	43	6.8
Western basin	26	8.4	14	9.0	12	7.8
Central basin	41	7.1	20	9.2	20	5.4
Eastern basin	22	8.4	11	8.8	11	8.0

TABLE 7.—*Dissolved oxygen in Lake Erie*

Station number	Depth (ft)	Temperature (°F)	Dissolved oxygen (ppm)	Approximate oxygen saturation (percent)
P-1-2	surface	70.2	10.0	115
P-1-2	15.0	70.2	9.5	110
P-1-2	30.0	70.2	9.5	110
P-1-5	surface	71.0	10.0	115
P-1-5	7.5	70.0	9.5	110
P-1-5	15.0	70.0	9.5	110
P-2-1	surface	73.5	10.0	120
P-2-2	surface	69.9	10.0	115
P-2-3	surface	70.1	9.0	105
P-3-1	surface	73.0	8.0	95
P-3-1	15.0	72.7	8.0	95
P-3-5	surface	74.2	8.5	105
P-3-5	32.5	72.2	8.0	95
P-3-8	surface	75.5	8.0	95
P-3-8	19.0	73.5	6.0	70
P-4-2	surface	75.5	12.0	145
P-4-2	30.0	71.8	9.0	105
P-4-4	surface	76.5	11.0	135
P-4-4	30.0	72.8	8.0	95
P-4-6	surface	75.5	10.0	120
P-4-8	surface	75.7	10.0	120
P-5-1	surface	72.8	8.0	95
P-5-1	25.0	72.8	7.0	85
P-5-3	surface	73.0	9.0	105
P-5-3	36.0	72.5	6.0	70
P-5-5	surface	73.0	8.0	95
P-5-5	35.0	73.0	7.0	85
P-5-6	surface	74.5	8.0	95
P-5-6	33.0	73.6	8.0	95
P-5-7	surface	73.5	8.0	95
P-5-7	32.0	73.2	9.0	105
P-5-8	surface	74.5	8.5	105
P-5-8	27.0	74.2	8.0	95
P-5-9	surface	75.0	9.0	110
P-5-9	22.0	74.8	9.0	110

TABLE 7.—*Dissolved oxygen in Lake Erie*—Continued

Station number	Depth (ft)	Temperature (°F)	Dissolved oxygen (ppm)	Approximate oxygen saturation (percent)
P-6-1	surface	72.5	8.0	95
P-6-1	15.0	71.9	8.0	95
P-6-3	surface	71.8	10.0	115
P-6-3	45.0	60.8	1.5	15
P-6-5	surface	72.5	11.0	120
P-6-5	37.0	70.5	8.0	90
P-6-5	45.0	63.8	3.0	30
P-6-7	surface	72.8	9.0	105
P-6-7	40.0	57.2	3.0	30
P-6-8	surface	73.1	10.0	120
P-6-8	17.5	64.3	7.0	75
P-6-10	surface	72.0	9.5	110
P-6-10	65.0	51.8	4.0	35
P-7-1	surface	69.0	9.0	100
P-7-1	41.0	51.5	3.0	30
P-7-3	surface	71.5	9.0	105
P-7-3	76.0	50.0	6.0	55
P-7-6	surface	72.0	9.0	105
P-7-6	83.0	49.2	6.0	55
P-7-9	surface	72.7	9.0	105
P-7-9	67.0	50.2	4.0	35
P-7-11	surface	73.8	9.5	115
P-7-11	42.0	70.5	6.0	70
P-8-1	surface	74.2	7.0	85
P-8-1	28.0	80.7	6.0	75
P-8-2	surface	72.5	8.0	95
P-8-2	34.0	71.9	9.0	105
P-8-6	surface	71.7	9.0	105
P-8-6	78.0	50.8	4.0	35
P-8-10	surface	70.8	9.0	105
P-8-10	73.0	49.9	6.0	55
P-8-14	surface	69.3	9.5	105
P-8-14	34.0	55.0	5.0	50
P-9-2	surface	69.2	8.0	90
P-9-2	32.0	69.2	9.0	100
P-9-5	surface	72.0	9.0	105
P-9-5	65.0	52.0	4.0	35
P-9-8	surface	72.7	9.0	105
P-9-8	75.0	50.0	8.0	75
P-9-11	surface	74.0	9.5	115
P-9-11	49.0	70.5	7.0	80
P-10-2	surface	72.0	9.0	105
P-10-2	48.0	71.8	8.0	95
P-10-4	surface	71.8	9.0	105
P-10-4	115.0	41.8	9.0	75
P-10-6	surface	72.5	9.0	105
P-10-6	210.0	39.2	9.0	70
P-10-7	surface	73.8	9.0	105
P-10-7	11.3	71.8	8.0	95
P-10-9	surface	71.6	9.0	105
P-10-9	53.0	59.2	7.0	75
P-11-1	surface	70.1	9.0	105
P-11-1	40.0	66.5	8.0	90
P-11-4	surface	71.0	9.0	105
P-11-4	75.0	52.0	6.0	55
P-11-6	surface	73.2	9.0	105
P-11-6	64.0	50.0	8.0	75
P-12-1	surface	72.8	8.0	95
P-12-1	38.0	71.8	8.0	95
P-12-2	surface	73.5	8.0	95
P-12-2	63.0	68.5	7.5	85
P-12-3	surface	72.8	9.0	105
P-12-3	32.5	70.5	9.0	105
P-13-1	surface	71.5	8.0	95
P-13-2	surface	72.8	8.0	95
P-13-3	surface	72.0	6.0	70

7.0 ppm near the mouth of the Detroit River and, excluding harbor readings, the highest was 37.5 ppm at the head of the Niagara River. The increase in chloride-ion content is generally progressive from west to east: Lake St. Clair, 8.3 ppm; Detroit River, 12.6 ppm; western basin, 21.8 ppm; central basin, 32.6 ppm; eastern basin, 32.1 ppm; and Niagara River, 35.8 ppm.

Figure 9 illustrates the variation in chloride concentration across the mouth of the Detroit River for the three distinct water masses entering western Lake Erie. In the central basin the surface water appeared to have been influenced for several miles offshore by the high-chloride inflow of the Grand River and both surface and bottom patterns showed high concentrations of chloride in the Cleveland and Fairport areas. The eastern basin was fairly uniform in chloride content with a gradual increase toward the Niagara River.

Turbidity.—Turbidity measurements on surface and bottom water were made at approximately half of the stations. The data from these measurements are given

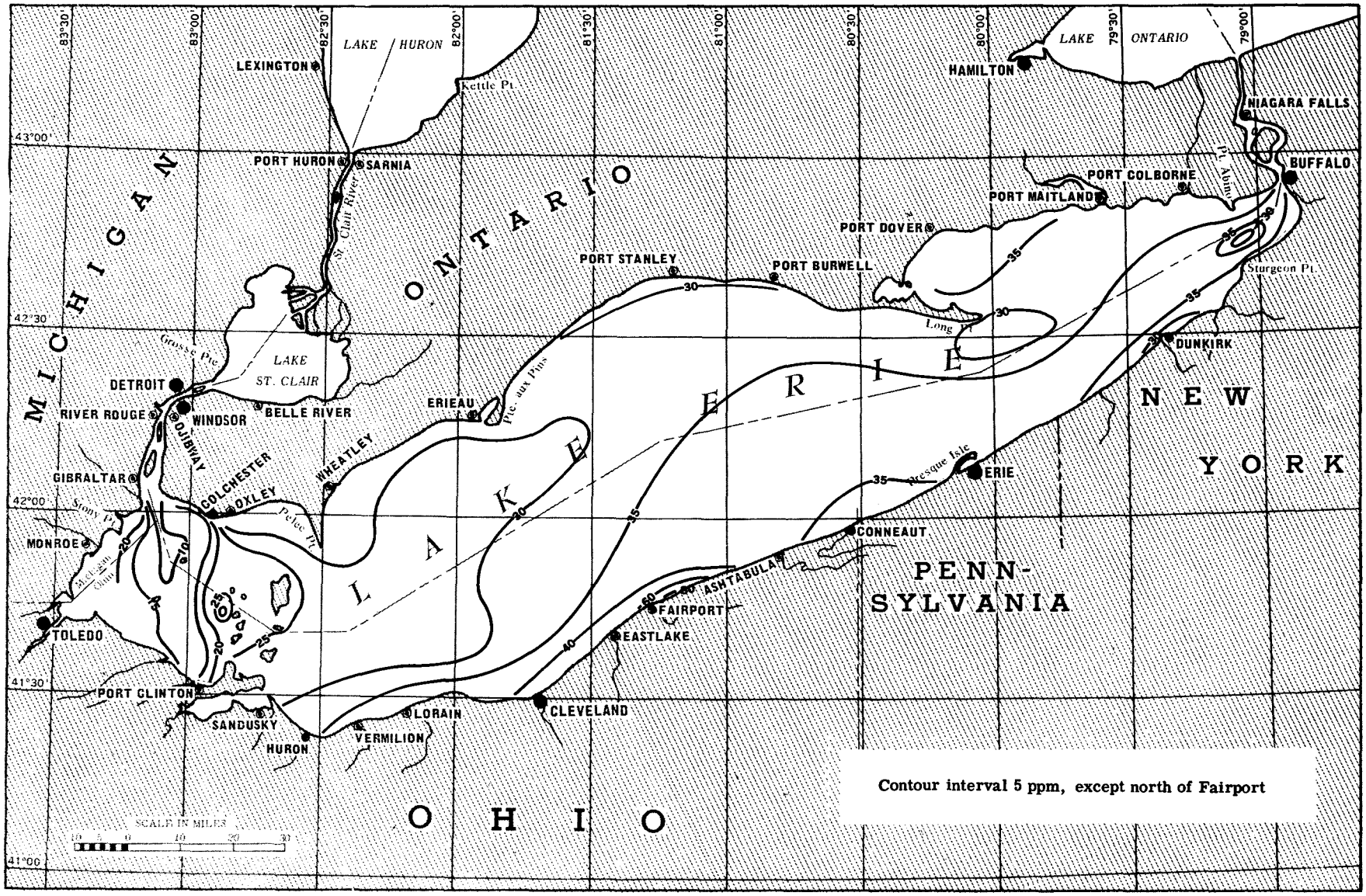


FIGURE 25.—Distribution of chloride ions in Lake Erie surface water.

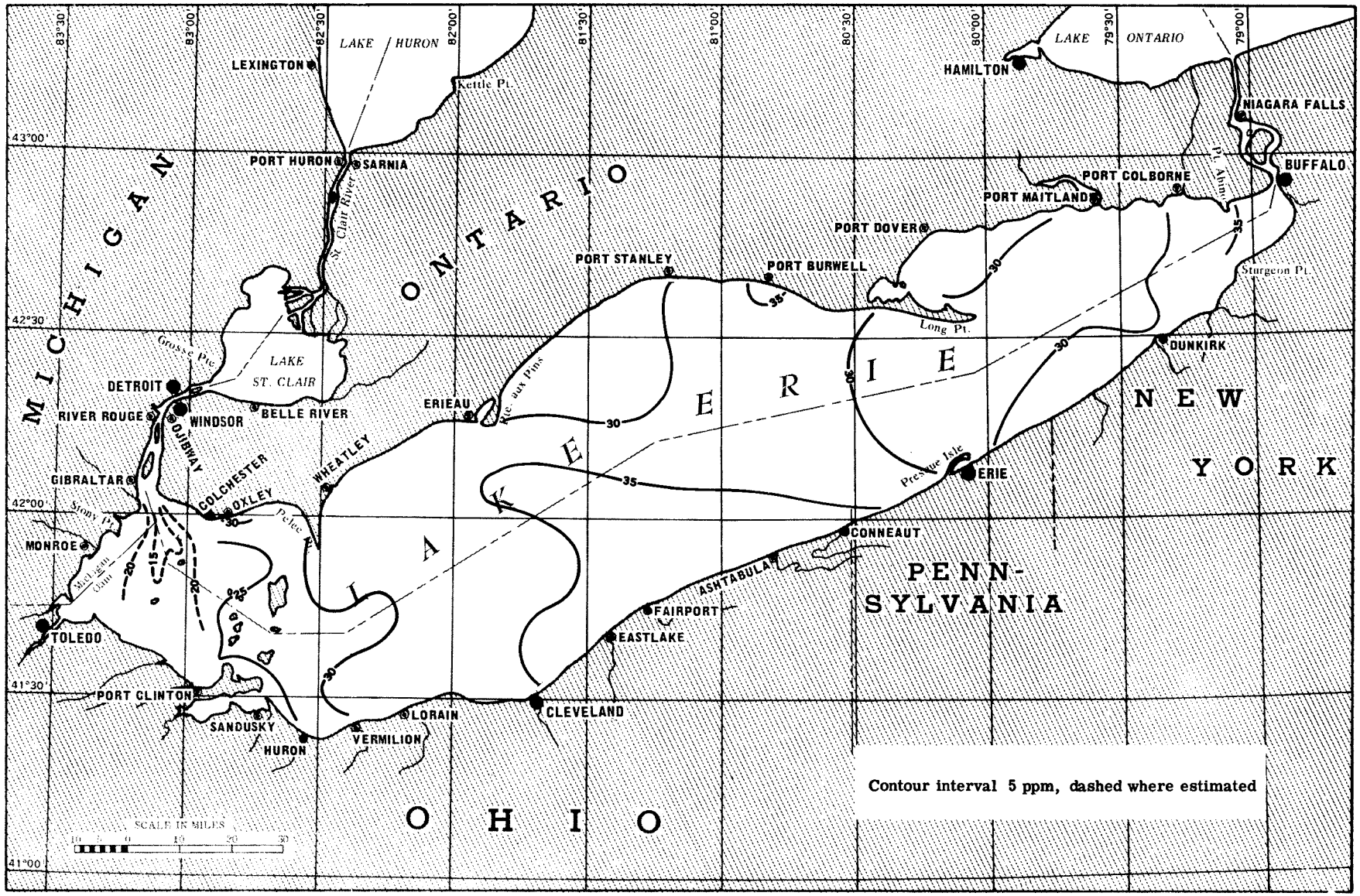


FIGURE 26.—Distribution of chloride ions in Lake Erie bottom water.

TABLE 8.—*Lake Erie chloride-ion summary*

Profile line or lake area	All measurements		Surface measurements		Bottom measurements	
	Number of readings	Average concentration (ppm)	Number of readings	Average concentration (ppm)	Number of readings	Average concentration (ppm)
P-1	3	8.3				
P-2	3	12.6				
P-3	3	14.0				
P-4	4	15.0				
P-5	14	25.4				
P-6	13	30.5				
P-7	10	33.7				
P-8	8	34.0				
P-9	8	33.4				
P-10	10	31.8				
P-11	6	31.6				
P-12	4	33.7				
P-13	3	35.8				
Lake Erie and connecting waterways	89	28.6	51	27.8	36	30.2
Lake Erie	80	29.7	44	28.7	35	30.8
Western basin	21	21.8	14	20.1	7	25.1
Central basin	39	32.6	19	32.8	19	32.7
Eastern basin	20	32.1	11	32.8	9	31.2

in summary form in table 9. Figure 27 shows the distribution of turbidity in the surface water of the lake. With the exception of the western basin, Lake Erie is low in turbidity. Average readings decreased from 19.0 Jackson Turbidity Units for the western basin to 4.0 for the central basin and 1.0 for the eastern basin. Bottom turbidity measurements averaged a little more than twice the surface readings. The high values for the western basin were apparently caused by phytoplankton and suspended sediment.

Water movements

Currents.—Profile current measurements were made at 58 stations. Tables 10 and 11 contain a summary of these measurements by station and by profile line, along with averages for surface, bottom, and thermoclinal currents. The resultant direction of all of the Lake Erie current measurements was south with an average velocity of 0.47 ft/sec. Surface currents had a resultant movement toward the southeast at 0.64 ft/sec, bottom currents toward the south-southwest at 0.44 ft/sec, and thermoclinal currents toward the south-southeast at 0.41 ft/sec.

Wind and surface currents were measured simultaneously at 49 stations in Lake Erie (table 12). When the direction toward which the wind was moving was compared with the surface current set for each station, it was found that the average current moved 16° to the right of the wind. When 15 of these stations were omitted from the calculations because of their proximity to the strong Detroit River flow or because winds were variable or very light, it was found that the average set of surface currents was 28° to the right of the direction toward which the wind was blowing. Theoretically, surface currents set 45° to the right of the wind for unrestricted bodies of water in the Northern Hemisphere (Donn, 1965).

Figure 28 illustrates the direction and velocity of surface and bottom currents that were measured in the western basin. The Detroit River was the controlling factor in water movement in the western part of the basin. However, measurements along profile lines 4, 5, and 6 showed the influence of southwest wind on the current directions. Surface currents generally moved with the wind while bottom currents were generally in opposition, presumably as subsurface return flows. The highest velocities were found in the narrow South Passage and east of Pelee Point off the Canadian shore. The lowest velocities occurred near the south shore of the western basin.

Current velocities and directions that were recorded in the central and eastern basins are shown in figure 29. Surface and bottom velocities were higher

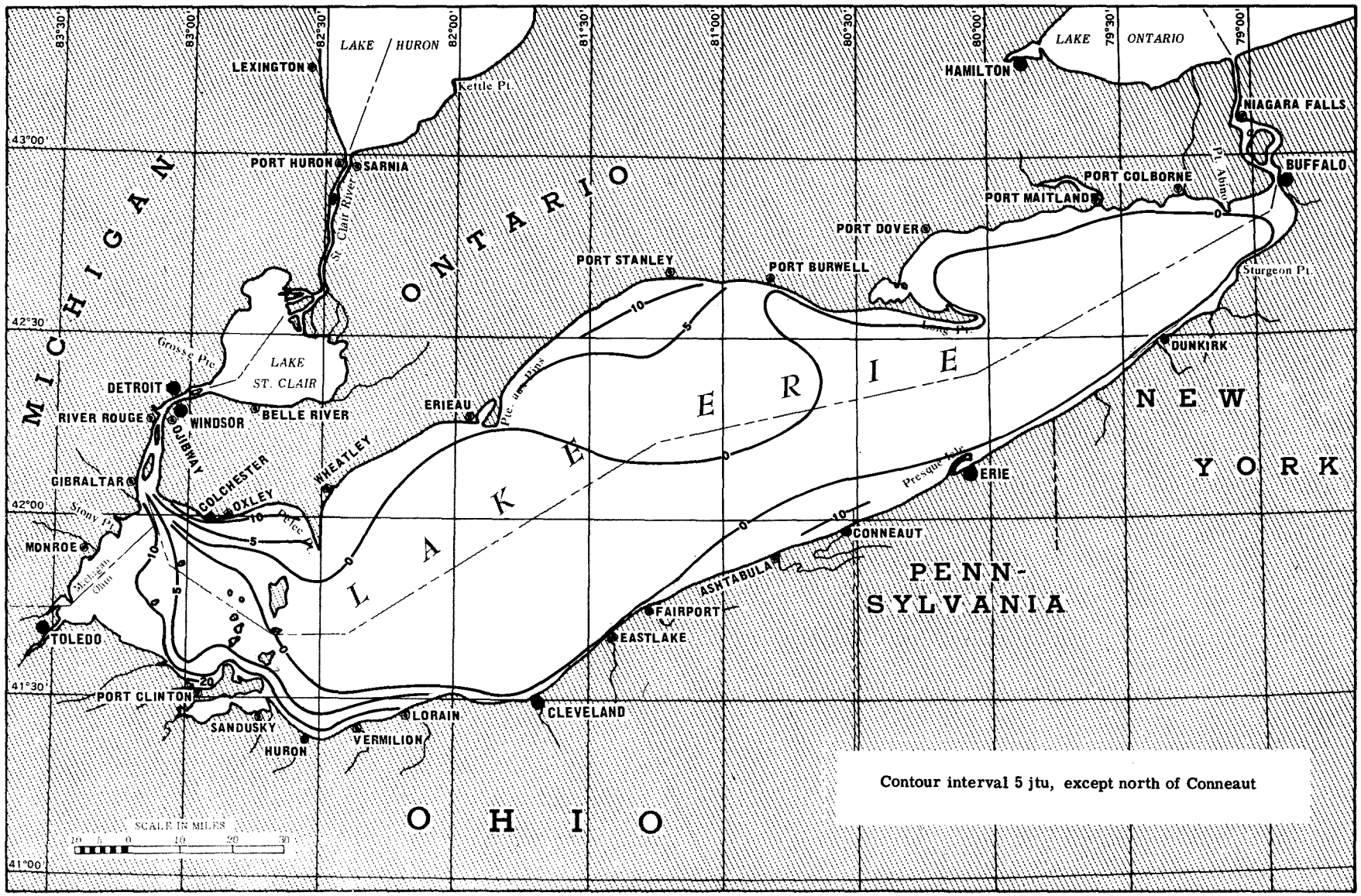


FIGURE 27.—Distribution of turbidity in Lake Erie surface water.

TABLE 9.—*Lake Erie turbidity summary*

Profile line or lake area	All measurements		Surface measurements		Bottom measurements	
	Number of readings	Average turbidity (jtu)	Number of readings	Average turbidity (jtu)	Number of readings	Average turbidity (jtu)
P-1	6	5				
P-2	3	19				
P-3	6	19				
P-4	6	18				
P-5*	12	8				
P-6	13	7				
P-7*	9	1				
P-8	10	7				
P-9	8	3				
P-10*	9	0				
P-11	6	3				
P-12	6	0				
P-13	3	0				
Lake Erie and connecting waterways	97	9	52	4	40	9
Lake Erie	85	8	44	4	38	9
Western basin	24	19	14	8	10	21
Central basin	40	4	19	2	18	8
Eastern basin	21	1	11	0	10	2

* Exceptionally high bottom readings excluded where disturbance of sediment is suspected.

TABLE 10.—*Lake Erie current summary*

Profile line or lake area	All measurements			Surface measurements			Thermoclinal measurements			Bottom measurements		
	Number of readings	Average direction (compass °)	Average velocity (ft/sec)	Number of readings	Average direction (compass °)	Average velocity (ft/sec)	Number of readings	Average direction (compass °)	Average velocity (ft/sec)	Number of readings	Average direction (compass °)	Average velocity (ft/sec)
P-1	11	217	0.64									
P-2	11	202	1.80									
P-3	26	246	0.30									
P-4	20	214	0.31									
P-5	46	164	0.44									
P-6	47	171	0.48				3	173	0.28			
P-7	36	203	0.58				4	75	0.34			
P-8	48	222	0.60				4	247	0.59			
P-9	42	201	0.58				3	171	0.54			
P-10	47	102	0.50				3	85	0.25			
P-11	24	166	0.22				2	77	0.36			
P-12	16	199	0.44									
P-13	1	40	7.85									
Lake Erie and connecting waterways	375	183	0.54	58	140	0.82				53	211	0.48
Lake Erie	352	184	0.47	53	138	0.64	19	144	0.41	49	209	0.44
Western basin	92	198	0.37	16	121	0.66				16	218	0.39
Central basin	173	199	0.56	23	143	0.75	14	166	0.45	22	216	0.52
Eastern basin	87	137	0.41	14	149	0.44	5	82	0.29	11	184	0.33

TABLE 11.—*Lake Erie currents, station measurements*

Station number	Number of readings	Average direction (compass °)	Average velocity (ft/sec)
P-1-2	7	222	0.70
P-1-5	4	206	0.54
P-2-1	4	190	0.47
P-2-2	7	208	2.55
P-3-1	4	317	0.29
P-3-3	6	170	0.29
P-3-5	7	204	0.29
P-3-7	5	233	0.27
P-3-8	4	360	0.36
P-4-2	7	207	0.30
P-4-4	7	262	0.10
P-4-6	3	262	0.80
P-4-8	3	66	0.32
P-5-1	6	191	0.43
P-5-3	8	148	0.42
P-5-5	7	250	0.48
P-5-6	7	96	0.44
P-5-7	7	92	0.40
P-5-8	6	179	0.41
P-5-9	5	210	0.50
P-6-1	3	148	0.16
P-6-3	10	250	0.38
P-6-5	9	140	0.37
P-6-7	8	148	0.48
P-6-8	4	147	0.48
P-6-10	13	150	0.57
P-6-11	1	80	1.50
P-7-1	9	70	0.80
P-7-3	9	98	0.39
P-7-6	10	182	0.42
P-7-9	9	215	0.38
P-7-11	9	225	0.30
P-8-2	7	282	0.46
P-8-3	8	268	0.67
P-8-6	9	118	0.57
P-8-10	9	239	0.67
P-8-13	8	150	0.59
P-8-14	7	303	0.57
P-9-2	6	256	0.61
P-9-3	7	229	0.61
P-9-5	9	120	0.75
P-9-8	10	188	0.58
P-9-11	10	235	0.36
P-10-2	6	117	0.47
P-10-4	12	113	0.46
P-10-6	19	50	0.58
P-10-7	3	215	0.57
P-10-9	6	154	0.20
P-10-10	1	200	1.00
P-11-1	5	156	0.17
P-11-2	1	135	0.28
P-11-3	1	40	0.40
P-11-4	10	163	0.21
P-11-6	7	200	0.21
P-12-1	5	250	0.26
P-12-2	7	212	0.23
P-12-3	4	111	0.36
P-13-1	1	40	7.85

in the central basin, particularly near the north shore. Surface directions were largely influenced by the wind. Bottom currents were generally moving in widely different directions and probably represented compensating flows. The following discussion of individual current measurement stations will consider the mechanics of subsurface currents in more detail.

Current meter data from 12 representative stations are graphed on polar coordinate diagrams in figure 30. Measurements at Station P-3-5 illustrate the effect of Detroit River flow on lake currents several miles south of the river mouth. Currents from surface to bottom were moving toward the south-southwest, in direct opposition to the wind. The surface currents had highest velocities and subsurface currents showed a slight shift to the right.

Station P-4-2, near Monroe, Michigan, demonstrates typical currents in western Lake Erie, where there is an absence of thermal stratification. The surface currents were being driven toward the north-northeast by south-southwest winds, while the subsurface currents indicated compensating return flow toward the southwest. The high velocity of the currents at the 28-foot depth indicated that the greatest volume of return flow was taking place near the bottom.

Station P-5-1, near Colchester, Ontario, shows a surface flow, under the influence of wind, moving toward Pelee Passage. Subsurface currents were here also opposed to the surface flow, possibly indicating an influx of central basin water, at depth, through Pelee Passage. High transparency readings (fig. 18) in Pigeon Bay appear to substantiate this conclusion. Of interest is the 25° shift of the surface current to the right of the wind progression and the increasing shift to the right with depth of the subsurface currents.

Station P-5-8, north of Catawba Island, shows wind-driven surface currents flowing about 37° to the right of the wind. Shallow subsurface currents were shifted progressively toward the right with increasing depth. These shifts are probably geostrophic deflections related to Coriolis effect in the Northern Hemisphere. The bottom currents were the most rapid (1.1 ft/sec) and represented a large volume of water moving into the western basin.

Currents were measured on July 30, 1967, south of Pelee Point, Station P-6-7, three days after measurements at Station P-5-1. The July 30 measurements showed that the surface and subsurface currents above the thermocline were then flowing out of the western basin through Pelee Passage toward the east-southeast at right angles to the wind. A flow toward the north was found below the thermocline, possibly a result of thermocline tilting by the large volume of water moving toward the southeast.

Station P-6-10 demonstrates typical central basin currents when the water is thermally stratified. The surface currents were moving with the wind toward the northeast. Subsurface currents from the 5-foot depth down to the thermocline showed a swing to the right

TABLE 12.—*Summary of meteorological observations*

Area	Wind velocity			Wind direction	Wind bearing (compass °)	Surface current set (compass °)	Wind and current set difference (°)	Remarks
	Number of readings	Highest (mph)	Average (mph)					
Lake Erie and connecting waterways	106	23.0	6.4					Air temperature during the entire cruise (110 readings): high 86°F, low 69°F, average 78°F
Lake Erie	94	23.0	6.1	SW	50	78	28	
Western basin	25	23.0	8.3	SW	45	74	29	
Central basin	49	13.0	5.0	NW	135	142	7	
Eastern basin	20	8.0	4.3	W	92	133	41	

from the north to the southeast. Below the thermocline the upper hypolimnion currents were similar to the lower epilimnion currents. Toward the bottom there was a velocity increase along with a continuing swing toward the right until at the bottom very rapid currents were flowing toward the southwest, in opposition to the surface currents.

Station P-7-9, north of Cleveland, Ohio, illustrates the currents developed under the influence of a moderate northeast wind. Epilimnion currents were driven toward the southwest. A 27° shift to the right was indicated from the surface to the current at the 40-foot depth. Below the thermocline, currents were relatively weak and toward the southeast.

During a calm period, currents measured south of Port Stanley, Ontario, at Station P-8-13 showed relatively rapid currents toward the southeast and south in the upper epilimnion, with the typical shift to the right. The currents decreased in velocity with increase in depth. Hypolimnion currents were moderate and toward the north and east.

At Station P-9-5 in the eastern part of the central basin between Conneaut, Ohio, and Port Burwell, Ontario, similar circumstances were noted. Wind-driven surface currents were toward the northeast. With depth, subsurface currents progressively migrated around the compass to a heading of southeast at 30 feet. Below the thermocline the currents in the upper hypolimnion were toward the northeast, while bottom currents were over 1.0 ft/sec with a northerly set.

Station P-10-6, over the "deep hole" in the eastern basin, revealed epilimnion currents with a shift from east-southeast at the surface to southwest near the thermocline. In contrast to some areas of deep currents in the central basin, all of the hypolimnion current measurements from 50 feet to 180 feet fell within a 30° arc in the northeast quadrant.

Measurements at station P-11-6, north of Dunkirk, New York, yielded southwest currents in a narrow band at all depths, presumably under the influence of a north-northeast wind. The only variation from this southwest current direction was the highly variable flow measured in the thermocline zone. Wide fluctuations in direction and velocity in the metalimnion were also noted at several other stations in the central and eastern basins.

Station P-12-2, between Sturgeon Point, New York, and Point Abino, Ontario, is typical of the eastern basin where no thermocline is present. A near-classical situation is illustrated by the set of the surface current to the right of the wind direction and by subsurface shifts to the right and decreases in current velocities with depth.

Waves.—Wave direction and height were estimated at most stations. Normally, wave progression was in the same direction as the wind movement except for a number of stations in the central basin where swells generated by earlier winds were at variance with light winds at the time of measurement. The wind-wave relationship for five selected stations is shown in table 13.

Water levels.—Lake Erie water levels during the period of the cruise are graphed in figure 31. Mean

TABLE 13.—*Lake Erie wave-data summary*

Station number	Water depth (ft)	Direction	Fetch (mi)	Height (ft)	Length (ft)	Period (sec)	Wind direction and velocity (mph)
P-1-2	31.5	NW	3	1½	15	2-3	NW 17-21
P-1-5	15.5	NW	10	1-2	15-20	2-3	NW 10
P-3-8	19.7	SW	14	½-1	5	1	SW 5-10
P-6-4	45.0	SW	12	1-2	15	2-3	SW 8-12
P-6-10	65.0	SW	20	2	15-20	2-3	SW 5

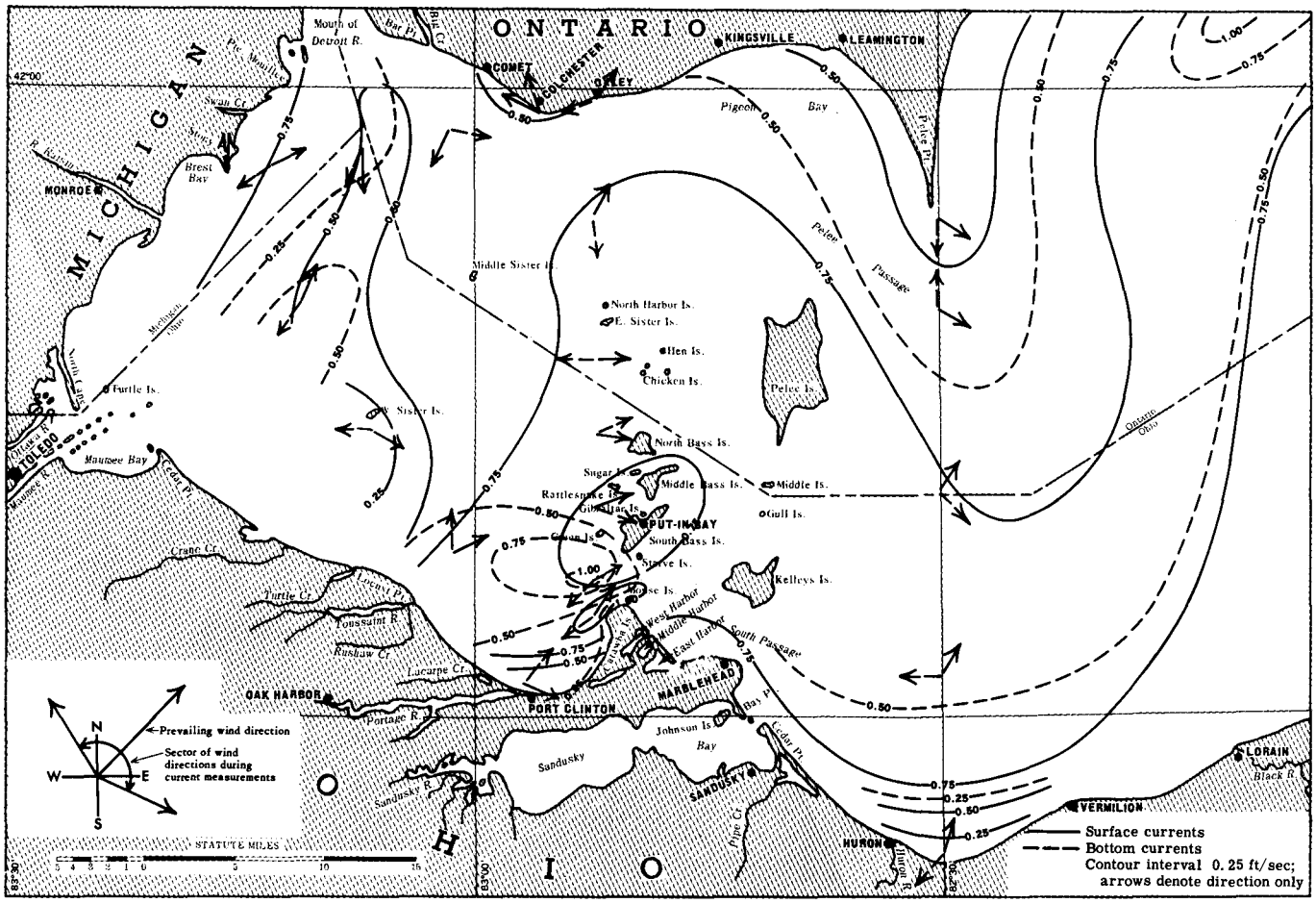


FIGURE 28.—Velocity and direction of surface and bottom currents in western Lake Erie.

daily levels fluctuated less than a foot during the cruise, except at Buffalo on August 3, 1967. Sustained southwest winds on that day caused a sharp rise in the water level at the eastern end of the lake. The ensuing longitudinal seiche on August 4, 1967, is illustrated in figure 32. The period of the seiche was approximately 12 hours, indicating that it may have been slightly oblique to the longitudinal axis of the lake. During most of the cruise, winds were blowing either southwest or northeast, nearly parallel to this axis. This fact is reflected in the water levels by compensating highs and lows at the east (Buffalo) and west (Toledo) ends of the lake.

Bottom deposits

Bottom surface samples or cores were collected and described at about half of the physical limnology stations. Perhaps the most significant information obtained from these samples was the delineation of (1) areas of deposition and (2) areas of erosion or nondeposition (fig. 33). Large areas of sand and glacial till bottom adjacent to the north shore and sizable reaches of sand and gravel, bedrock, and glacial till bottom along the south shore are assumed to be areas of nondeposition. Silt and clay mud bottoms in the deeper parts of the basins are the only areas of present deposition other than littoral sand accumulations along the shoreline. Calculations show that approximately 58 percent of the lake bottom is within the area of deposition: western basin, 56 percent; central basin, 60 percent; and eastern basin, 52 percent.

Detailed mechanical and mineralogical analysis of the bottom samples was not undertaken as part of the present study, but the samples have been retained for future study.

COMBINED DISCUSSION

The physical limnology of western Lake Erie is strongly influenced by Detroit River flow. This inflow is composed of three distinct water masses. The midchannel flow predominates and is characterized by (1) lower temperature, (2) lower specific conductance, (3) greener color and higher transparency, (4) lower pH,

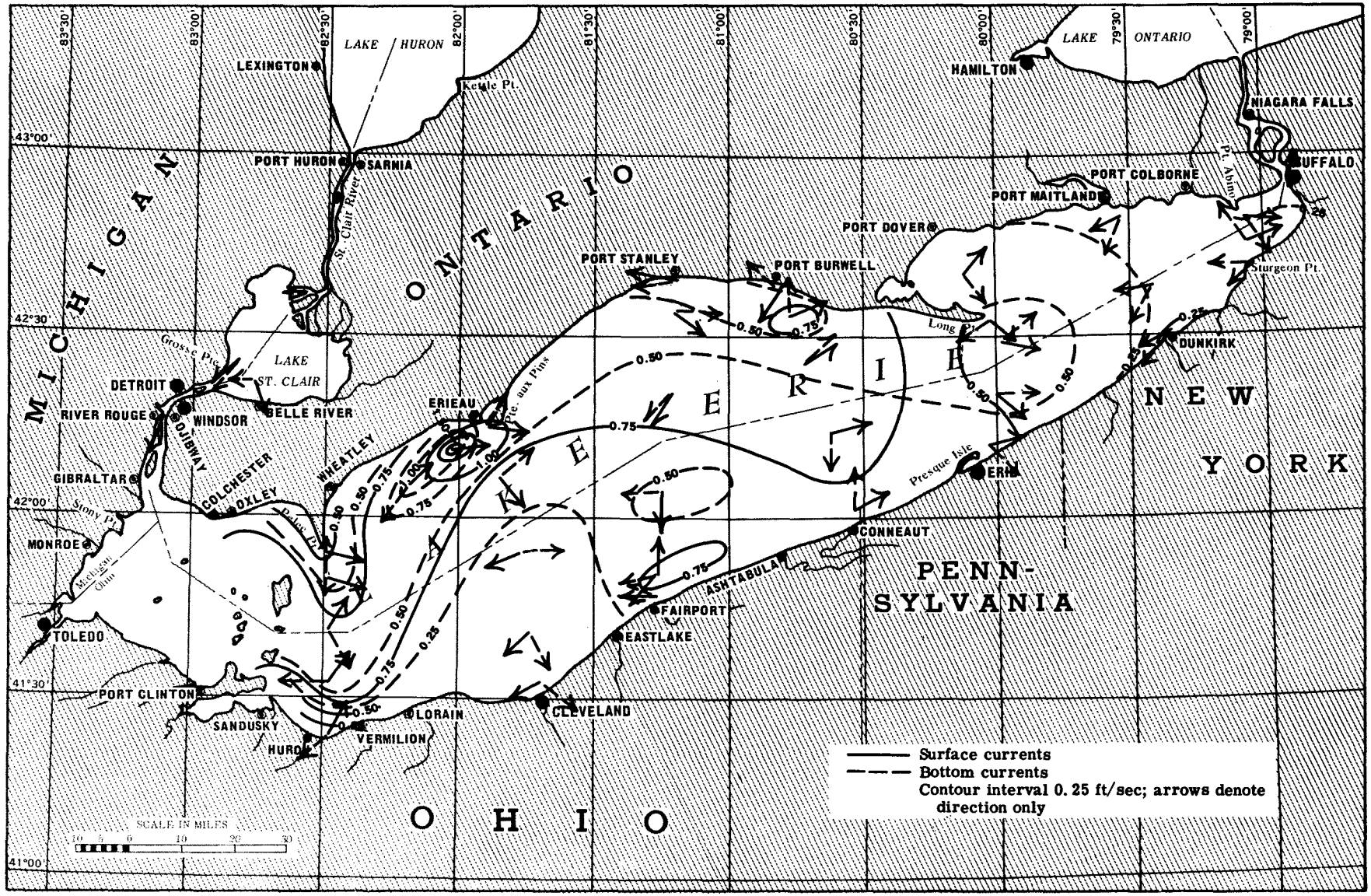


FIGURE 29.—Velocity and direction of surface and bottom currents in central and eastern Lake Erie.

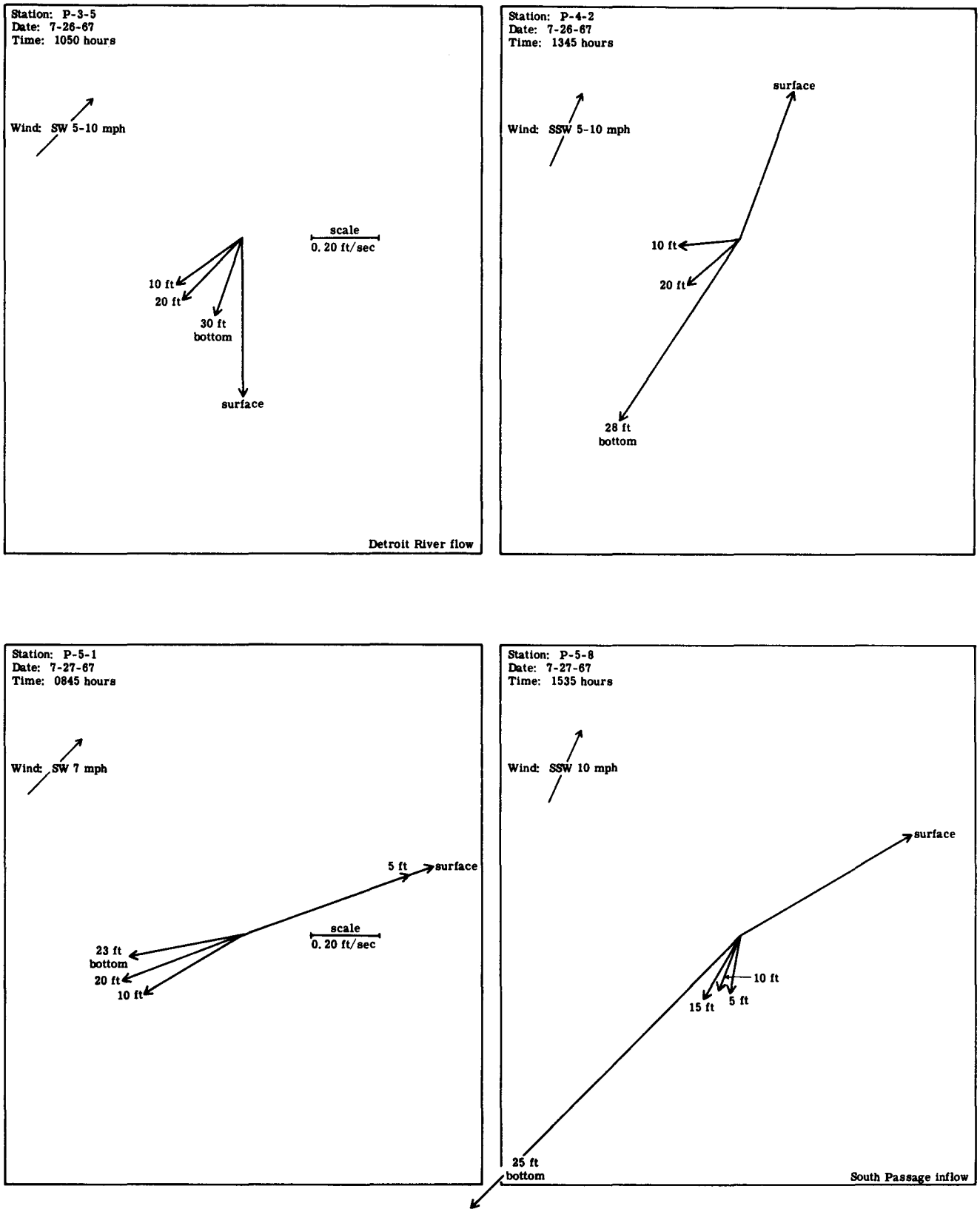
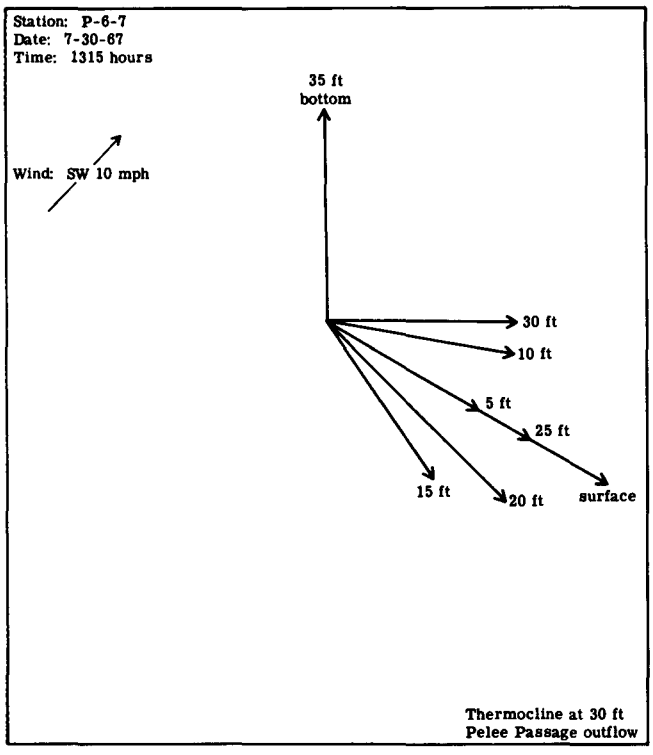
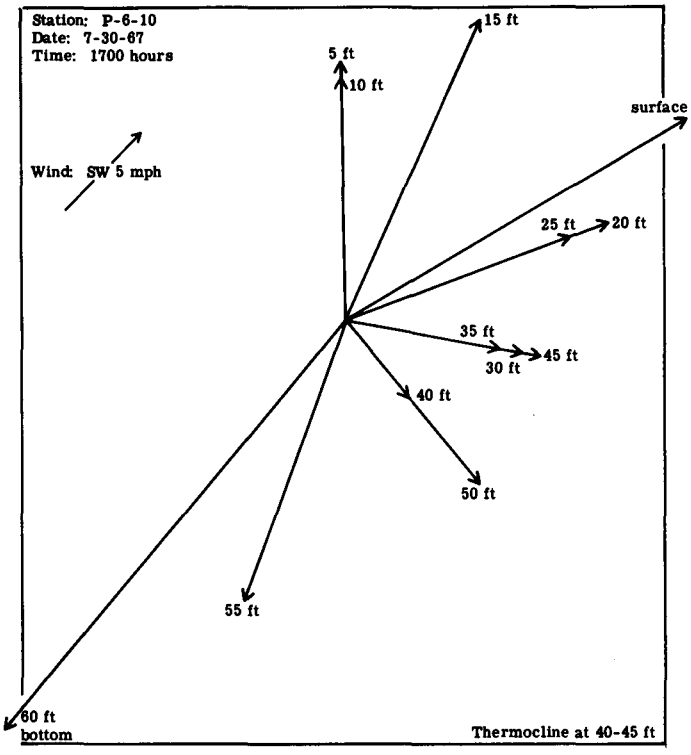
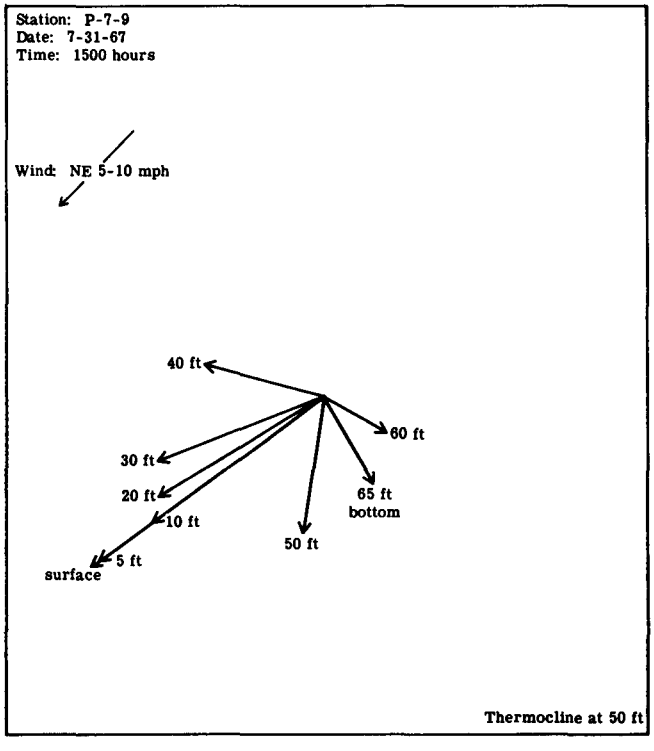


FIGURE 30.—Lake Erie current diagrams.







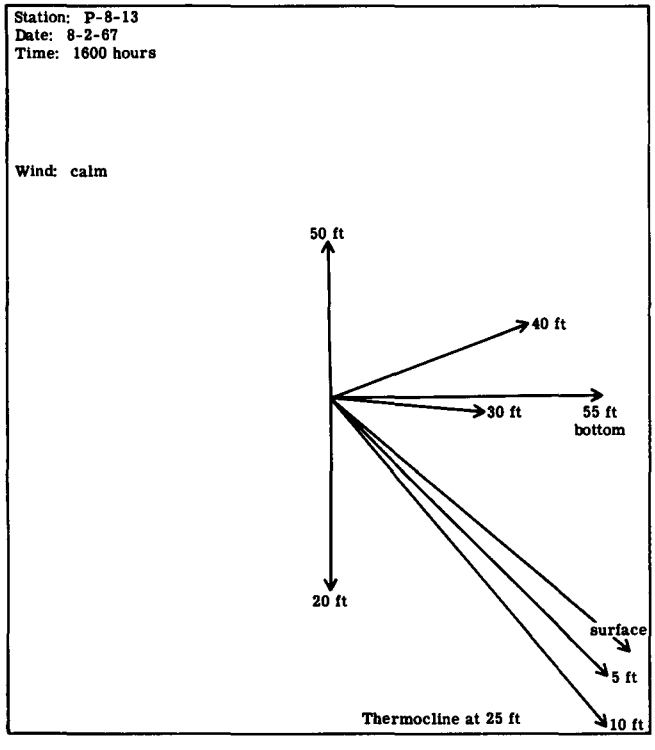


FIGURE 30.—Lake Erie current diagrams—*Continued.*

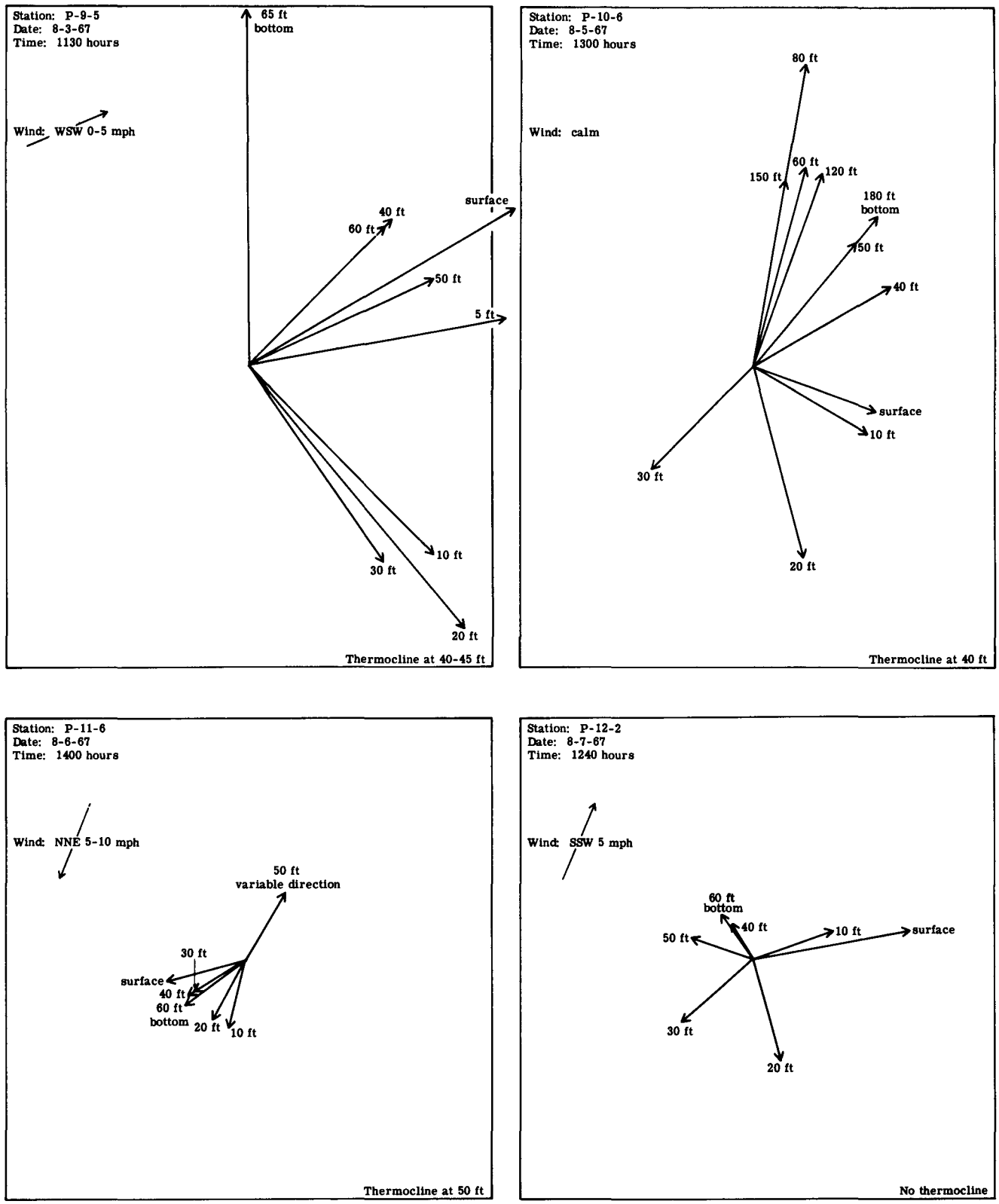


FIGURE 30.—Lake Erie current diagrams—*Continued.*

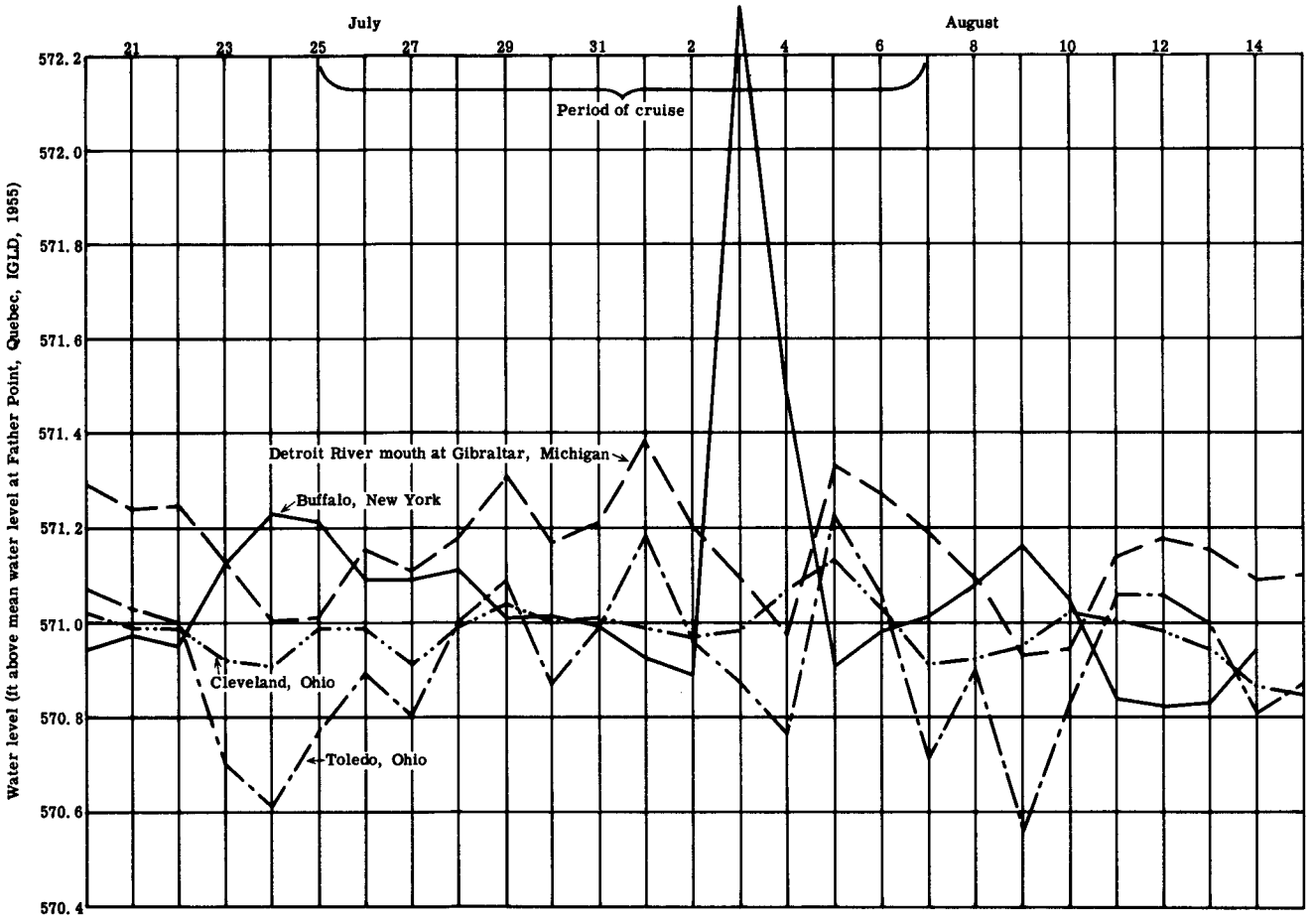


FIGURE 31.—Mean daily water levels for Lake Erie at Buffalo, Cleveland, Gibraltar, and Toledo.

(5) higher dissolved-oxygen content, (6) lower chloride-ion concentration, and (7) lower turbidity than the flows on the east and west sides of the river. The midchannel flow penetrates deeply into the western basin where it mixes with other masses and eventually flows into the central basin through Pelee Passage and to a lesser extent through South Passage. The side flows generally cling to the shoreline and recycle in large eddy currents.

In the central basin, the prevailing southwest winds are parallel to the longitudinal axis of the lake. Because of the rotation of the earth these winds generate currents which cause a geostrophic transport of water to the right toward the United States shore. This convergence of water along the south shore results in a rise in lake level which is equalized by sinking of water off the shore. At the same time the lake level is lowered along the Canadian shore as surface currents move the water offshore. The sinking along the south shore appears to be compensated by a subsurface movement of water toward the north and an upwelling along the Ontario shore.

The thermocline is approximately 35 feet shallower adjacent to the north shore than on the south side of the lake; this can be interpreted as an upwelling influenced by the prevailing southwest winds. The resultant surface currents indicate a net eastward movement, while subsurface readings show a slight net westward movement. This can best be explained by the cycle of (1) surface transport of water toward the southeast, sinking of water off the south shore, (3) subsurface transport toward the north-northwest, and (4) upwelling adjacent to the north shore. The pattern of this type of circulation would be analogous to coils of a spring that tapers toward the eastern end of the lake.

The formation of a deep thermocline in the southern half of the central basin results in a relatively thin hypolimnion which is highly susceptible to oxygen depletion by sediments with high oxygen demands. These circumstances presumably resulted in the presence of bottom water with as low as 15 percent dissolved oxygen saturation in the southwestern part of the basin.

The bottom deposits of the northern part of the central basin are predominantly glacial till and do not have the high oxygen demands of the clay muds in the southern half of the basin. This fact coupled with a thicker hypolimnion off the north shore apparently

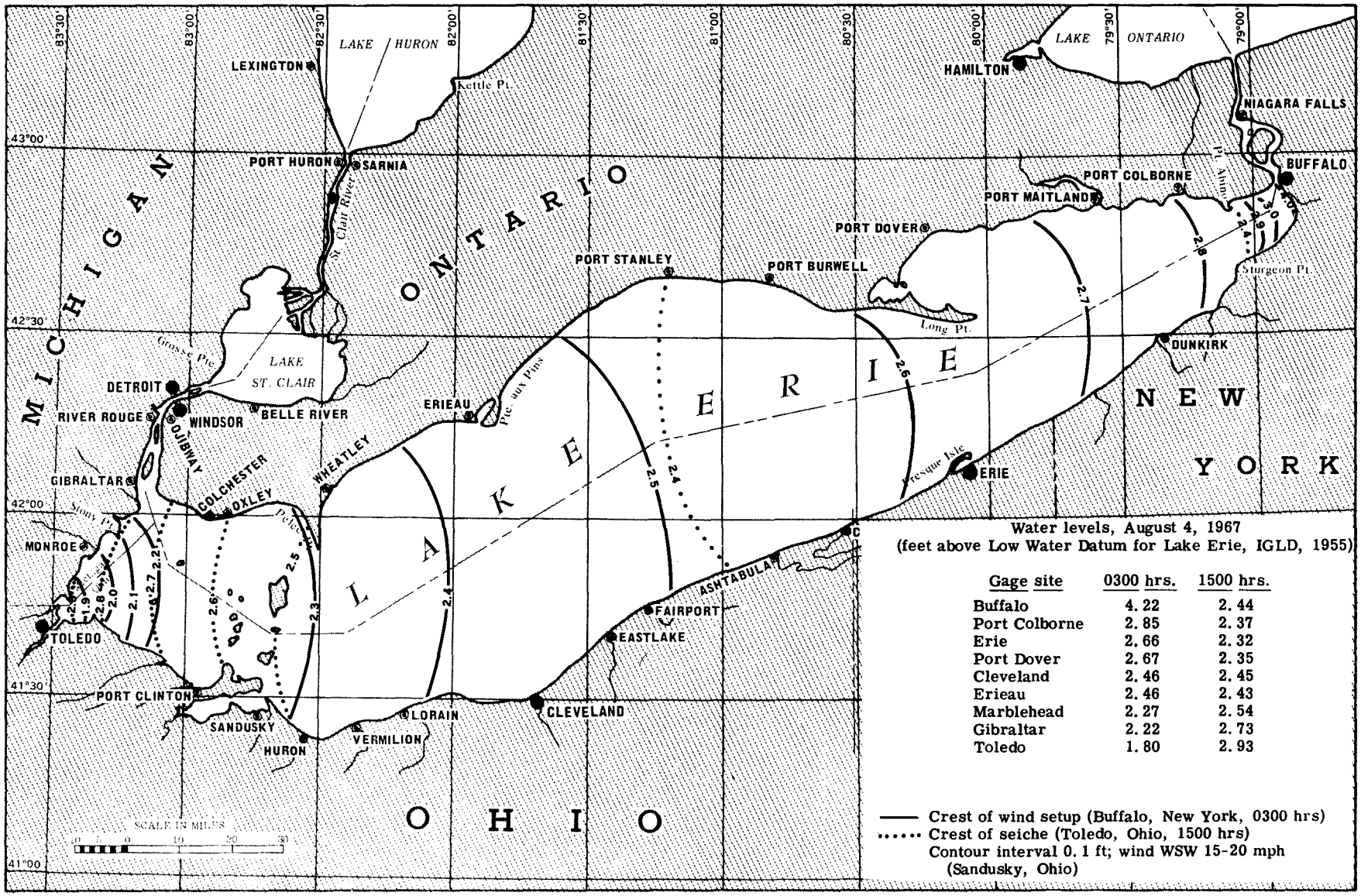


FIGURE 32.—Lake Erie water levels during a longitudinal seiche.

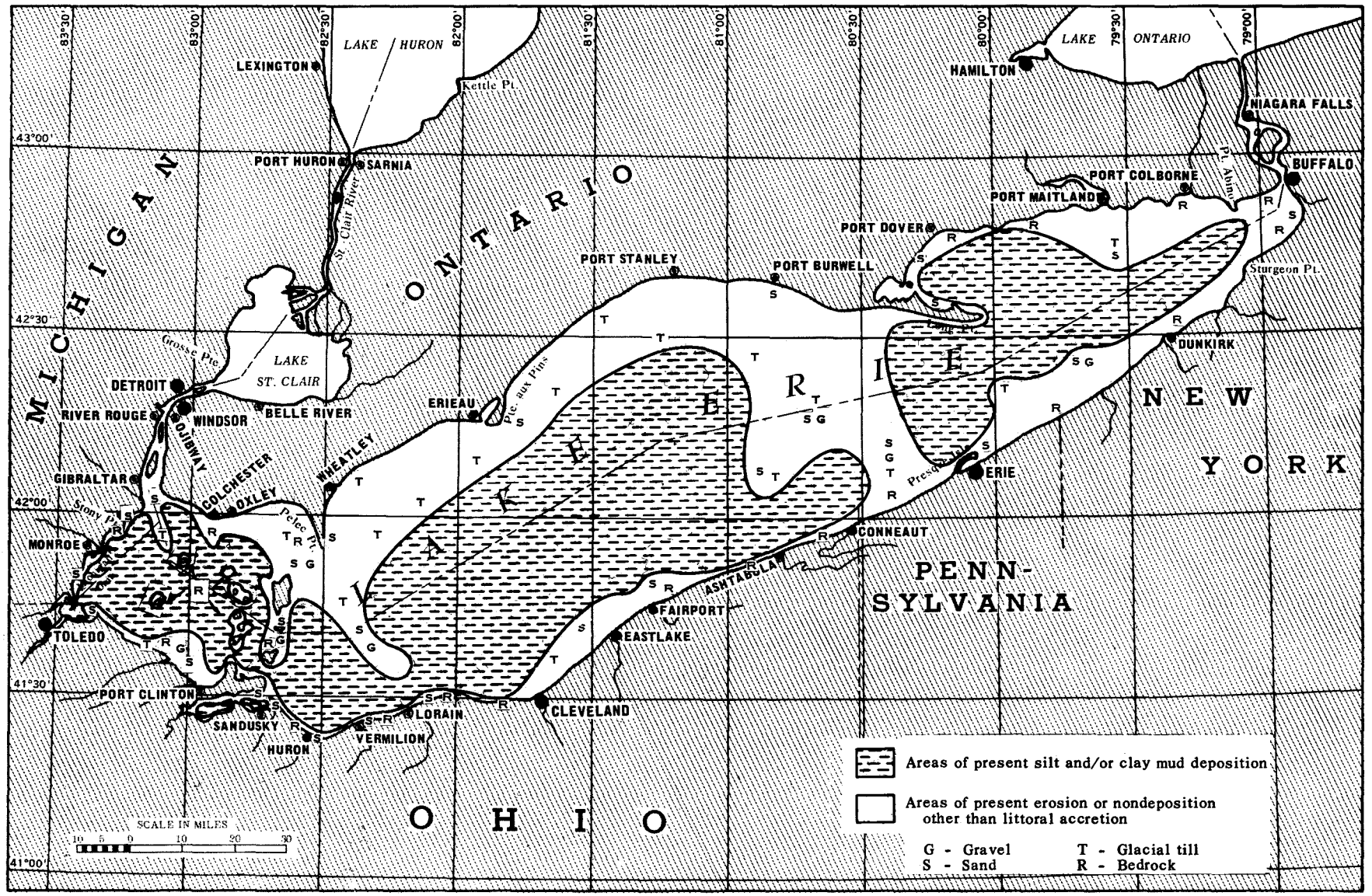


FIGURE 33.—Distribution of Lake Erie bottom deposits, showing areas of assumed deposition and erosion.

accounts for the more abundant dissolved oxygen at the bottom.

In the eastern basin the thermocline over the "deep hole" was at a depth of 40 feet allowing a considerably deeper hypolimnion (170 feet) than in the central basin. As a result, the dissolved oxygen content of the bottom water was approximately 70 percent of saturation.

Dissolved solids showed a marked increase from Lake St. Clair to the Niagara River. Specific conductance indicated an approximate rise of 40 percent, while threefold chloride increases were more dramatic.

In general, midlake water in the central and eastern basins of Lake Erie, lakeward of a narrow band of shore-influenced water, is relatively uniform and of good quality. Some variation in the concentration of dissolved substances occurs between the epilimnion and hypolimnion waters and is probably caused by the oxygen demand and the solutioning of the sediments.

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APPENDIX

PROFILE LINE 1
LAKE ST. CLAIR: GROSSE POINTE, MICHIGAN, TO BELLE RIVER, ONTARIO

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-1-1 7-25-67 1730	42°26'00"	82°52'10"	13.0	NW 5	NW ½	brown-green	2.4	75	surface 2.5 5.0 7.5 10.0 12.5	72.0 71.5 71.5 71.5 71.5 71.5	211 211 211 211 212 212							
P-1-2 7-25-67 1400	42°24'30"	82°50'00"	31.5	NW 17-21	NW 1-1½	green, cloudy	3.1	80	surface 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 30.0	70.2 70.2 70.2 70.2 70.2 70.2 70.2 70.2 70.2 70.2 70.2 70.2 70.0	198 198 197 197 197 197 197 197 197 197 197 197 195	230 230 230 200 200 240 230	0.84 0.68 0.76 0.68 0.51 0.84 0.59	8.45 8.10 8.30	10.0 9.5 9.5	7.0 10.0 8.0	9 8 8	Bottom material: silty gray clay mixed with gravel, probably partially reworked glacial till. Additional wave data: length: 15 ft; period: 2-3 sec.
P-1-3 7-25-67 1510	42°23'00"	82°48'10"	18.0	NW 10-15	NW 1	green, cloudy	5.3	79	surface 2.5 5.0 7.5 10.0 12.5 15.0 17.5	70.0 69.2 69.0 69.0 69.0 69.0 69.0 68.5	197 197 199 199 199 199 199 222							
P-1-4 7-25-67 1525	42°21'20"	82°46'10"	18.0	NW 10-15	NW 1-2	green, clear	8.4	78	surface 2.5 5.0 7.5 10.0 12.5 15.0 17.5	70.2 70.2 70.2 70.2 70.2 70.2 70.2 69.0	200 200 200 200 200 200 201 232							
P-1-5 7-25-67 1540	42°19'40"	82°44'10"	15.5	NW 10	NW 1-2	green, cloudy	6.6	76	surface 2.5 5.0 7.5 10.0 12.5 15.0	71.0 70.2 70.0 70.0 70.0 70.0 70.0	217 218 217 218 218 218 221	160 160 235 270	0.63 0.59 0.55 0.42	8.50 8.65 8.40	10.0 9.5 9.5		2 0 0	Bottom material: stiff pebble-rich gray clay, probably glacial till. Additional wave data: length, 15-20 ft; period, 2-3 sec.
P-1-6 7-25-67 1630	42°18'10"	82°42'10"	8.0	NW 10	NW 2	brown-green	1.9	76	surface 2.5 5.0 7.5	75.0 74.5 74.5 73.5	218 215 215 218							

PROFILE LINE 2
DETROIT RIVER: RIVER ROUGE, MICHIGAN, TO OJIBWAY, ONTARIO

Station no. Date Time	Surface observations								Depth observations								Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-2-1 7-25-67 1900	42°15'20"	83°07'10"	15.0	NW 5	calm	brown	2.0	72	surface 2.5 5.0 7.5 10.0 12.5 14.0	73.5 72.5 72.0 72.0 72.0 71.9 71.9	255 258 260 260 260 260 255	190 190 190 190	0.34 0.42 0.72 0.42	8.35	10.0	15.0	42	
P-2-2 7-25-67 2000	42°15'20"	83°06'50"	35.0	NW 5	calm	green	4.5	72	surface 2.5 5.0 7.5 10.0 15.0 20.0 25.0 30.0 35.0	69.9 69.5 69.5 69.5 69.2 69.2 69.2 69.2 69.2 69.2	198 198 198 198 198 198 198 198 198 198	200 200 200 210 205 220 225	2.70 2.53 2.70 2.70 2.36 2.53 2.36	8.40	10.0	15.0	10	
P-2-3 7-25-67 1930	42°15'20"	83°06'40"	22.5	NW 5	calm	green, cloudy	3.6	72	surface 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5	70.1 70.1 69.7 69.5 69.5 69.5 69.5 69.5 69.5 69.5	248 300 271 238 228 295 265 300 370 365			8.40	9.0	8.0	5	

PROFILE LINE 3
WESTERN LAKE ERIE: COLCHESTER, ONTARIO, TO STONY POINT, MICHIGAN

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-3-1 7-26-67 0900	41°58'50"	82°55'50"	16.0	WNW 5	calm	green-brown, cloudy	3.3	75	surface	73.0	255	300	0.42	8.34	8.0	15.0	13	Bottom material: gray-brown mud mixed with fine to coarse sand.
									2.5	72.9	255							
									5.0	72.8	255	270	0.25					
									7.5	72.8	255							
									10.0	72.6	255	355	0.21					
									12.5	72.6	255	345	0.29					
									15.0	72.6	255			8.45	8.0		19	
P-3-2 7-26-67 0945	41°58'30"	82°58'40"	30.0	W 5	W ½	green, clear	7.2	76	surface	72.9	250							
									2.5	72.7	250							
									5.0	72.7	250							
									7.5	72.6	250							
									10.0	72.5	250							
									12.5	72.5	250							
									15.0	72.5								
									20.0	72.5	250							
									25.0	72.5	255							
									30.0	70.9	340							
											(probe in mud)							
P-3-3 7-26-67 1000	41°57'50"	83°01'30"	28.5	W 0-5	W ½	green, clear	7.8	77	surface	72.5	225	200	0.63					Bottom material: smooth gray-brown mud.
									2.5	72.0	225							
									5.0	72.0	225	200	0.17					
									10.0	72.0	225	200	0.20					
									15.0	71.9	225	165	0.12					
									20.0	71.9	225	160	0.20					
									25.0	71.9	230	100	0.42					
									28.0	70.8	245							
P-3-4 7-26-67 1030	41°57'30"	83°04'20"	28.0	SW 5	W ½	green	6.3	75	surface	72.5	210							
									2.5	72.0	210							
									5.0	72.0	211							
									10.0	71.8	213							
									15.0	71.7	215							
									20.0	71.5	215							
									25.0	71.5	215							
									27.5	71.5	250							
P-3-5 7-26-67 1050	41°57'10"	83°07'20"	33.0	SW 5-10	WSW ½	green, cloudy	4.0	75	surface	74.2	202	180	0.46	8.38	8.5	7.0	10	Bottom material: brown till clay, rich in sand and pebbles.
									2.5	73.5	202							
									5.0	73.5	202	200	0.34					
									10.0	73.2	201	235	0.29					
									15.0	73.0	201	235	0.29					
									20.0	72.8	201	225	0.25					
									25.0	72.8	202	225	0.21					
									30.0	72.5	202	200	0.24					
									32.5	72.2	205			8.25	8.0		15	

P-3-6 7-26-67 1130	41°56'40"	83°10'10"	23.5	SW 5-10	SW ½-1	brown	2.8	76	surface 2.5 5.0 10.0 15.0 20.0 23.0	74.5 74.5 74.2 74.0 73.8 73.5 73.5	275 275 275 275 275 275 295								
P-3-7 7-26-67 1145	41°56'10"	83°12'50"	25.0	SW 5-10	SW ½-1	brown-green	4.8	76	surface 2.5 5.0 10.0 15.0 20.0 25.0	74.2 74.2 74.1 73.5 73.5 73.5 73.2	255 255 260 272 272 272 302	75 270 315 250 255	0.71 0.20 0.19 0.12 0.17						Bottom material: smooth gray-brown mud with numerous shell fragments.
P-3-8 7-26-67 1230	41°55'40"	83°15'40"	19.7	SW 5-10	SW ½-1	green-brown	3.1	77	surface 2.5 5.0 10.0 15.0 19.0	75.5 75.0 74.5 74.2 73.7 73.5	290 290 290 287 282 282	0 0 0 0 	0.85 0.24 0.19 0.17 	8.62 8.30	8.0 6.0	20.0	12 45	Bottom material: gray-brown mud. Additional wave data: length, 5 ft; period, 1 sec.

PROFILE LINE 4
WESTERN LAKE ERIE: STONY POINT, MICHIGAN, TO PORT CLINTON, OHIO

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-4-1 7-26-67 1315	41°52'40"	83°13'20"	27.0	SSE 5-10	SW ½ SSE ½	green	6.4	80	surface 2.5 5.0 10.0 15.0 20.0 25.0 27.0	74.8 74.8 74.5 73.5 73.0 72.8 72.8 71.8	218 225 250 250 252 255 255 255							Algae turbidity, Aphanizomenon.
P-4-2 7-26-67 1345	41°49'30"	83°11'00"	30.0	SSW 5-10	5½	green	3.9	82	surface 2.5 5.0 10.0 15.0 20.0 25.0 28.0 30.0	75.5 75.5 75.0 73.5 72.9 72.7 72.5 71.8	219 220 218 221 225 225 230 239	20 260 265 230 230 235 215	0.46 0.24 0.19 0.20 0.20 0.20 0.63	8.65 8.50	12.0 9.0	15.0	10 18	Bottom material: dark-gray mud. Algae turbidity, Aphanizomenon.
P-4-3 7-26-67 1430	41°46'40"	83°08'40"	28.0	SSW 5-10	SSW ½	green	4.6	82	surface 2.5 5.0 10.0 15.0 20.0 25.0 28.0	74.5 74.5 74.5 74.1 73.0 72.5 72.5 72.0	230 230 232 225 235 235 235 238							Algae turbidity, Aphanizomenon.
P-4-4 7-26-67 1500	41°42'40"	83°06'20"	30.0	SW 5-10	SSW ½-1	green	4.8	82	surface 2.5 5.0 10.0 15.0 20.0 25.0 28.0 30.0	76.5 76.2 76.2 74.2 73.7 73.2 73.0 72.8	237 238 239 239 243 243 245 248	110 270 280 300 335 270 270	0.25 0.04 0.04 0.04 0.04 0.04 0.25	8.68 8.45	11.0 8.0	15.0	14 40	Bottom material: smooth gray clay.
P-4-5 7-26-67 1540	41°40'40"	83°04'00"	27.5	SW 5-10	SW 1	green	7.5	81	surface 2.5 5.0 10.0 15.0 20.0 25.0 27.0	75.8 75.9 74.9 74.7 74.0 73.5 73.2 73.2	245 245 245 245 248 248 248 250							
P-4-6 7-26-67 1600	41°37'50"	83°01'10"	7.5	WSW 20-25	WSW 1-2	green	6.0	80	surface 2.5 5.0 7.0	75.5 75.5 75.5 75.5	245 248 250 250	68 0 0	0.97 0.76 0.68	8.62	10.0	15.0	5	Bottom material: dolomite bedrock and gravel rubble.

Station no. Date Time	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	Remarks
P-4-7 7-26-67 1640	41°34'30"	82°59'20"	21.0	SW 15-20	SW 2	green	5.7	78	surface 2.5 5.0 10.0 15.0 20.0	75.4 74.8 74.8 74.8 74.8 74.5	245 245 245 245 255 255							
P-4-8 7-26-67 1700	41°31'30"	82°57'10"	11.0	SW 5-10	SW 1	green, cloudy	3.0	76	surface 2.5 5.0 9.0 10.5	75.7 75.7 75.5 75.5 75.5	260 260 261 270 270	110 45 45	0.38 0.22 0.38	8.69	10.0	15.0	20	Bottom material: hard gray-brown till clay, rich in pebbles.

PROFILE LINE 5
WESTERN LAKE ERIE: OXLEY, ONTARIO, TO CATAWBA ISLAND, OHIO

Station no. Date Time	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	Remarks
P-5-1 7-27-67 0845	41°59'00"	82°52'20"	26.0	SW 7	SW 1	green, cloudy	3.9	76	surface 2.5 5.0 10.0 15.0 20.0 23.0 25.0	72.8 72.8 72.8 72.8 72.8 72.8 72.8	242 242 245 245 242 242 242	70 70 240 260 250 260	0.59 0.51 0.34 0.46 0.38 0.34	8.12 8.11	8.0 7.0	30.0 30.0	11 18	Bottom material: gray-brown to red till clay, rich in sand and pebbles.
P-5-2 7-27-67 0915	41°57'10"	82°52'20"	33.0	SW 0-5	SW 1-½ (swells)	green, clear	10.8	77	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 33.0	73.2 73.5 73.5 73.5 73.5 73.5 73.5 73.2 72.5	239 239 239 239 239 239 239 239 355							
P-5-3 7-27-67 0940	41°53'50"	82°52'20"	36.5	WSW 7	WSW 1	green, clear	7.4	78	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 33.0 36.0	73.0 73.0 73.0 73.0 73.0 73.0 73.0 73.0 73.0 73.0	225 225 225 230 230 230 230 230 230 230	70 70 160 180 160 200 180 170	0.76 0.42 0.38 0.42 0.46 0.29 0.30 0.38	8.29 8.37	9.0 6.0	22.5 22.5	0 135	Bottom material: smooth medium-gray mud.
P-5-4 7-27-67 1025	41°50'20"	82°52'20"	29.0	WSW 15-20	WSW 2	green, clear	8.0	78	surface 2.5 5.0	72.7 73.0 73.0	225 225 225							Bottom material: dolomite bedrock.

PROFILE LINE 5 - continued

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass°)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-5-4 (con'd)									10.0	73.0	227							
									15.0	73.0	227							
									20.0	72.9	228							
									25.0	72.9	229							
									28.0	72.8	230							
P-5-5 7-27-67 1050	41°46'50"	82°52'20"	35.5	SSW 5-10	SSW 2	green, clear	6.3	78	surface	73.0	215	90	0.85	8.32	8.0	24.0	3	Bottom material: smooth medium-gray mud.
									2.5	73.3	230							
									5.0	73.3	230	310	0.47					
									10.0	73.3	232	250	0.38					
									15.0	73.3	232	240	0.42					
									20.0	73.2	235	315	0.46					
									25.0	73.2	235	280	0.46					
									30.0	73.2	235	270	0.38					
									35.0	73.0	238			8.44	7.0	24.0		
P-5-6 7-27-67 1135	41°43'20"	82°52'20"	34.0	WSW 6-8	WSW 1-2	green, clear	7.0	81	surface	74.5	255	100	0.97	8.53	8.0	30.0	2	Bottom material: smooth gray mud.
									2.5	74.2	255							
									5.0	74.2	252	100	0.38					
									10.0	74.2	255	85	0.38					
									15.0	74.0	253	120	0.34					
									20.0	74.0	255	120	0.30					
									25.0	73.8	255	90	0.38					
									30.0	73.8	255	60	0.34					
									33.0	73.6	255			8.30	8.0	25.0	12	
P-5-7 7-27-67 1215	41°39'50"	82°52'20"	32.0	WSW 7	WSW 1 (swells)	green	6.3	78	surface	73.5	255	70	0.68	8.47	8.0	23.0	1	Bottom material: smooth gray mud.
									2.5	74.0	255							
									5.0	73.9	255	90	0.36					
									10.0	73.9	250	90	0.34					
									15.0	73.9	260	105	0.34					
									20.0	73.8	261	60	0.42					
									25.0	73.8	261	120	0.37					
									28.0			110	0.29					
									30.0	73.7	261							
									32.0	73.2	362 (probe in mud)			8.08	9.0	26.0	14	
P-5-8 7-27-67 1535	41°36'20"	82°52'20"	27.5	SSW 10	SSW 1-1½	green	4.8	75	surface	74.5	265	60	0.59	8.34	8.5	25.0	7	Bottom material: silty dark-gray mud.
									2.5	74.5	265							
									5.0	74.5	265	190	0.17					
									10.0	74.5	265	200	0.22					
									15.0	74.2	265	210	0.22					
									20.0	74.2	265	190	0.19					
									25.0	74.2	265	225	1.10					
									27.0	74.2	268			8.47	8.0	23.5	11	
P-5-9 7-27-67 1610	41°34'30"	82°52'20"	22.0	SSW 15-20	SSW 1-1½	green, cloudy	3.2	77	surface	75.0	263	50	1.03	8.53	9.0	25.0	8	Bottom material: medium-gray mud.
									2.5	75.0	263							
									5.0	75.0	264	270	0.51					
									10.0	75.0	265	270	0.37					
									15.0	75.0	265	225	0.34					
									18.0			235	0.25					
									20.0	75.0	265							
									22.0	74.8	319			8.51	9.0	25.0	13	

PROFILE LINE 6
CENTRAL LAKE ERIE: HURON, OHIO, TO PELEE POINT, ONTARIO, TO ERIEAU, ONTARIO

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-6-1 7-30-67 0715	41°23'10"	82°30'00"	15.0	SSW 8	SSW ½	green, clear	6.0	69	surface 2.5 5.0 10.0 15.0	72.5 72.0 72.0 72.0 71.9	260 262 262 264 265	20 200 225 	0.25 0.12 0.12 	7.38 8.27	8.0 8.0	35.0 30.0	14 0	Bottom material: medium to fine sand. Plankton turbidity, Daphnia.
P-6-2 7-30-67 0815	41°27'30"	82°30'00"	42.0	SW 8-10	SW 1	dark green, clear	8.9	72	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 42.0	72.0 72.0 72.0 72.0 72.0 72.0 72.0 72.0 71.9 71.9 70.8 66.2 62.3 61.2 60.2 60.2 60.2 60.0 60.0	265 265 265 265 265 265 265 265 268 272 275 283 280 290 291 292 292 292 292								Bottom material: smooth medium-gray mud.
P-6-3 7-30-67 0905	41°31'50"	82°30'00"	45.0	SW 8-10	SW 1½-2	dark green, clear	15.6	75	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 32.5 35.0 37.5 40.0 42.5 45.0	71.8 71.8 71.8 71.8 71.8 71.8 71.8 71.8 71.5 71.0 70.8 62.5 60.8 60.8	270 270 270 270 270 270 271 271 268 270 270 272 291 297	30 290 355 190 225 215 285 345 290 270 	0.80 0.39 0.34 0.29 0.12 0.34 0.34 0.41 0.22 0.59 	8.63 8.34	10.0 1.5	30.0 31.0	0 0	Bottom material: gray-brown mud.
P-6-4 7-30-67 1000	41°36'10"	82°30'00"	45.0	SW 8-12	SW 1-2	dark green, clear	12.2	86	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 32.5 35.0	72.0 72.0 72.0 72.0 72.0 72.0 72.0 71.8 71.8 71.8	248 252 258 258 260 260 265 265 265 265							Bottom material: gray-brown mud. Additional wave data: length, 15 ft; period, 2-3 sec.

PROFILE LINE 6 - continued

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-6-4 (con'd)									37.5	71.8	265							
									40.0	64.2	290							
									42.5	64.0	282							
									45.0	63.8	320							
P-6-5 7-30-67 1040	41°40'30"	82°30'00"	44.5	SW 10-15	SW 2	dark green	10.0	81	surface	72.5	262	30	0.76	8.62	11.0	27.5	0	Bottom material: gray-brown mud.
									2.5	72.2	262							
									5.0	72.2	263	45	0.24					
									10.0	72.2	263	320	0.29					
									15.0	72.1	262	60	0.22					
									20.0	72.0	262	135	0.37					
									25.0	72.0	263	180	0.36					
									30.0	72.0	263	180	0.17					
									35.0	71.8	265	180	0.38					
									36.0	71.5								
									37.0	70.5								
									38.0	65.5				8.30	8.0	30.0	0	
									39.0	64.3								
									40.0	64.0	282	135	0.56					
									41.0	63.8								
									42.0	63.8								
									43.0	63.8								
									44.0	63.8								
									45.0	63.8	304			8.39	3.0	30.0	30	
P-6-6 7-30-67 1150	41°44'50"	82°30'00"	39.0	SW 8-10	SW 2	dark green, clear	13.2	82	surface	72.5	260							Bottom material: fine dark-gray-brown sand and silt with shell fragments.
									2.5	72.5	260							
									5.0	72.5	261							
									10.0	72.2	262							
									15.0	72.1	261							
									20.0	72.1	261							
									25.0	72.0	262							
									30.0	71.9	265							
									32.5	71.9	265							
									35.0	71.0	265							
									37.5	68.5	275							
									39.0	67.5	275							
P-6-7 7-30-67 1315	41°49'50"	82°30'00"	40.5	SW 10	SW 2	green	8.1	82	surface	72.8	245	120	0.71	8.26	9.0	27.0	0	Bottom material: reddish-gray till clay, rich in coarse sand, with some brown silt above.
									2.5	72.5	245							
									5.0	72.5	245	120	0.38					
									10.0	72.5	245	100	0.42					
									15.0	72.5	245	145	0.42					
									20.0	72.2	245	135	0.55					
									25.0	71.5	245	120	0.51					
									30.0	67.0	260	90	0.42					
									32.5	66.2	262							
									35.0	61.5	278	0	0.46					
									37.5	58.2	288							
									40.0	57.2	290			8.46	3.0	30.5	21	

P-6-8 7-30-67 1410	41°53'40"	82°30'00"	18.0	WNW 5	WNW $\frac{1}{2}$ SW (swells)	green	6.4	78	surface 2.5 5.0 7.5 10.0 12.5 15.0 17.5	73.2 73.2 73.0 71.0 65.1 64.9 64.5 64.2	238 238 242 245 268 268 268 268	110 120 180 180	0.46 0.42 0.57 0.47	8.57 8.42	10.0 7.0	30.5 31.0	2 0	Bottom material: medium sand.
P-6-9 7-30-67 1600	41°59'10"	82°21'10"	58.0	SW 5	SW 1	dark green, clear	9.7	78	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 58.0	71.9 71.9 71.9 71.9 71.9 71.0 64.2 51.9 51.8 51.8 51.8 51.8 51.8 51.8	260 260 260 260 255 248 265 295 295 290 295 295 295 295							Bottom material: sticky reddish-gray till clay, rich in sand and pebbles.
P-6-10 7-30-67 1700	42°04'50"	82°12'00"	65.0	SW 5	SW 2	dark green	12.8	78	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0	72.0 72.0 72.0 72.0 71.9 71.9 71.8 70.8 67.0 58.5 52.0 51.8 51.8 51.8 51.8	260 260 260 260 260 260 261 267 275 282 298 298 298 298 305	60 0 0 30 70 70 100 100 140 100 140 200 225 	0.85 0.55 0.52 0.71 0.61 0.52 0.39 0.34 0.22 0.44 0.46 0.64 1.18 	8.50 7.90	9.5 4.0	29.5 34.0	0 22	Bottom material: stiff reddish-gray till clay and gravel. Additional wave data: length, 15-20 ft; period, 2-3 sec.
P-6-11 7-30-67 1820	42°10'20"	82°03'00"	53.0	SW 10	SW 2	dark green, clear	11.3	83	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 53.0	72.0 72.0 72.0 72.0 72.0 71.5 62.2 54.8 52.5 52.2 52.2 52.0 52.0	252 252 255 255 255 255 280 272 290 291 291 295 295	80 	1.50 					

PROFILE LINE 7
CENTRAL LAKE ERIE: ERIEAU, ONTARIO, TO CLEVELAND, OHIO

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-7-1 7-31-67 0730	42°14'00"	81°53'50"	41.0	WNW 5	W ½	dark green, clear	10.3	70	surface	69.0	258	100	1.13	8.38	9.0	32.5	0	Bottom material: reddish-gray till clay and gravel.
									2.5	69.0	258							
									5.0	69.0	259	100	1.22					
									10.0	69.0	259	100	1.17					
									15.0	68.8	260	105	1.06					
									20.0	65.2	275	110	0.78					
									25.0	64.5	280	35	0.41					
									27.5	52.4	282							
									30.0	52.4	282	35	0.52					
									35.0	51.8	282	30	0.36					
									40.0	51.5	284	20	0.59					
									41.0	51.5	282			8.10	3.0	30.5	0	
P-7-2 7-31-67 0830	42°09'50"	81°52'50"	65.0	NW 5	SW 1½ (swells)	dark green, clear	19.3	75	surface	70.8	245							Bottom material: reddish-gray till clay mixed with sand and pebbles.
									2.5	70.8	261							
									5.0	71.0	261							
									10.0	71.0	261							
									15.0	71.0	263							
									20.0	71.0	265							
									25.0	71.0	265							
									30.0	71.0	265							
									35.0	71.0	265							
									40.0	69.2	270							
									42.5	67.0	279							
									45.0	65.8	280							
									47.5	63.0	282							
									50.0	60.7	287							
									52.5	53.0	285							
									55.0	52.7	287							
									60.0	52.5	287							
									65.0	51.9	287							
P-7-3 7-21-67 0940	42°05'40"	81°51'40"	76.0	NW 0-5	SW 1 (swells)	dark green, clear	18.5	78	surface	71.5	265	150	0.59	8.63	9.0	29.5	0	Bottom material: smooth gray mud.
									2.5	71.8	265							
									5.0	71.2	265	120	0.21					
									10.0	71.0	265	100	0.46					
									15.0	71.0	268							
									20.0	71.0	268	145	0.42					
									25.0	71.0	268							
									30.0	71.0	268	135	0.36					
									35.0	71.0	268							
									40.0	71.0	268	110	0.51					
									45.0	69.0	270							
									50.0	66.3	272	45	0.46					
									55.0	62.8	275							
									60.0	50.5	289	40	0.21					
									65.0	50.2	290							
									70.0	50.0	290	40	0.36					
									76.0	50.0	335 (probe in mud)	variable		8.31	6.0	35.0	2	

P-7-4 7-31-67 1015	42°01'20"	81°50'40"	82.0	WSW 5	SW 1 (swells)	dark green, clear	28.1	80	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 82.0	71.8 71.8 71.8 71.8 71.8 71.0 70.9 70.8 70.8 70.8 70.5 68.5 65.8 54.5 49.5 49.5 49.5 49.2 49.2	272 272 272 272 272 272 272 272 272 275 275 275 278 282 290 290 290 339 358 (probe in mud)							Bottom material: soft gray mud.
P-7-5 7-31-67 1100	41°57'10"	81°49'30"	84.0	SW 5	SW 1 (swells)	dark green, clear	19.9	77	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 57.5 60.0 65.0 70.0 75.0 80.0 84.0	71.9 71.9 71.9 71.9 71.5 71.0 71.0 71.0 71.0 70.8 70.8 67.8 64.5 59.2 50.8 49.2 49.2 49.2 49.2 49.1	265 265 270 270 270 270 270 270 270 270 270 275 278 285 290 288 290 290 290 331							Bottom material: soft gray mud.
P-7-6 7-31-67 1150	41°53'00"	81°48'20"	83.0	WSW 5	SW $\frac{1}{2}$	dark green, clear	19.8	79	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 83.0	72.0 72.0 72.0 71.8 71.5 71.0 70.8 70.8 70.8 70.7 70.7 67.9 62.5 50.9 49.8 49.5 49.5 49.5 49.2	270 270 270 270 272 272 272 272 271 272 272 275 282 288 290 290 290 322 355	265 265 220 250 250 100 85 75 90 variable	0.42 0.34 0.42 0.32 0.25 0.20 0.36 0.27 0.21 1.01	8.50 7.40	9.0 6.0	31.5 34.5	0 102	Bottom material: soft gray-brown mud. Bottom turbidity, mostly algae.

PROFILE LINE 7 - continued

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-7-7 7-31-67 1340	41°48'50"	81°47'20"	78.0	calm	calm	dark green, algae	24.8	78	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 78.0	72.8 72.5 72.5 72.5 72.0 71.5 71.0 71.0 70.8 70.8 70.7 70.0 63.8 52.3 50.2 50.0 50.0 49.8	270 270 270 270 270 270 270 272 271 271 273 273 288 288 288 290 290 355 (probe in mud)							Bottom material: soft gray-brown mud.
P-7-8 7-31-67 1420	41°44'40"	81°46'10"	73.0	NW 5	calm	dark green, algae	24.7	80	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 73.0	72.5 72.5 72.5 72.0 71.8 71.0 71.0 71.0 71.0 71.0 70.8 70.8 66.5 51.8 50.8 50.2 50.0	271 271 272 270 270 272 272 271 271 272 272 273 282 297 295 295 385 (probe in mud)							Bottom material: soft gray-brown mud.
P-7-9 7-31-67 1500	41°40'20"	81°45'10"	67.0	NE 5-10	NE ½	dark green	18.8	79	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0	72.7 72.5 72.5 72.0 71.8 71.0 71.0 70.8 70.8 70.8	275 275 272 271 272 273 275 272 275 275	235 235 240 250 285	0.63 0.61 0.46 0.42 0.39 0.27	7.70	9.0	30.5	0	Bottom material: soft gray-brown mud.

									45.0	70.8	275							
									50.0	70.5	277	190	0.29					
									55.0	61.1	298							
									60.0	50.6	299	120	0.15					
									65.0	50.3	299	150	0.21					
									67.0	50.2	365 (probe in mud)			8.55	4.0	35.0	0	
P-7-10 7-31-67 1600	41°36'10"	81°44'00"	59.0	NE 5-10	NE 1	dark green, clear	18.2	79	surface	72.5	260							Bottom material: soft gray-brown mud.
									2.5	72.5	265							
									5.0	72.5	268							
									10.0	72.5	268							
									15.0	72.1	275							
									20.0	71.9	275							
									25.0	71.8	278							
									30.0	71.7	278							
									35.0	71.7	278							
									40.0	71.7	278							
									45.0	71.7	279							
									50.0	70.8	279							
									55.0	53.2	299							
									59.0	52.8	330							
P-7-11 7-31-67 1630	41°32'00"	81°42'50"	42.0	NE 5-10	NE 1	green	8.9	82	surface	74.0	285	245	0.59	8.56	9.5	42.5	0	Bottom material: firm gray-brown clay with sand and rounded pebbles, probably partially reworked till or clumped material.
									2.5	74.0	285							
									5.0	73.8	285	245	0.51					
									10.0	73.7	285	225	0.27					
									15.0	73.7	285	225	0.24					
									20.0	73.5	290	200	0.20					
									25.0	73.0	290	240	0.20					
									30.0	72.8	290	280	0.32					
									35.0	72.5	292	240	0.20					
									40.0	71.0	290							
									38.0			125	0.21					
									42.0	70.5	290			8.52	6.0	35.5	4	
P-7-12 7-31-67 1700	41°30'50"	81°43'00"				green	8.3	79	surface	76.2	335							
P-7-13 7-31-67 1705	41°30'40"	81°43'00"				green-brown	3.3	79	surface	75.5	475							
P-7-14 7-31-67 1710	41°30'20"	81°42'40"				reddish brown	1.4	79	surface	78.0	860							
P-7-15 8-1-67 0830	41°32'40"	81°38'40"				brown-green	9.9	78	surface	73.3	298							
P-7-16 8-1-67 0930	41°39'20"	81°30'00"	37.0	NE 5-10	NE $1\frac{1}{2}$-2	brown-green	8.3	78	surface	72.8	283							Bottom material: sandy gray-brown mud.
									2.5	73.3	285							
									5.0	73.5	285							
									10.0	73.5	286							
									15.0	73.2	286							
									20.0	72.4	285							
									25.0	72.4	290							
									30.0	71.1	285							
									35.0	70.7	287							
									37.0	70.1	287							

PROFILE LINE 8
CENTRAL LAKE ERIE: FAIRPORT, OHIO, TO PORT STANLEY, ONTARIO

Station no. Date Time	Surface observations								Depth observations								Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-8-1 8-2-67 0655	41°45'40"	81°16'40"	28.0	SSE 0-5	calm	gray-green	6.2	72	surface	74.2	400			8.10	7.0	87.5	0	
									2.5	74.5	402							
									5.0	75.0	405							
									10.0	75.0	410							
									15.0	75.0	410							
									20.0	78.9	3700							
									25.0	80.0	5400							
									28.0	80.7	2950			7.22	6.0	1730.5	8	
P-8-2 8-2-67 0725	41°46'20"	81°16'20"	34.0	SSE 5	SSE ½	gray-green	6.4	72	surface	72.5	265	290	0.59	8.30	8.0	45.0	0	
									2.5	72.2	302							
									5.0	72.2	307	280	0.51					
									10.0	72.2	307	270	0.51					
									15.0	72.0	307	280	0.42					
									20.0	72.0	307	280	0.46					
									25.0	72.0	307	290	0.38					
									30.0	72.0	307	290	0.39					
									34.0	71.9	295			8.43	9.0	35.0	3	
P-8-3 8-2-67 0807	41°50'40"	81°16'20"	68.0	SSE 6	SSE 1-2	green	19.8	74	surface	71.8	275	355	0.96					
									2.5	71.8	275							
									5.0	71.8	275	275	0.59					
									10.0	71.8	275	290	0.46					
									15.0	71.5	275							
									20.0	71.5	275	265	0.55					
									25.0	71.5	275							
									30.0	71.5	275	265	0.71					
									35.0	71.2	275							
									40.0	71.0	275	250	0.83					
									45.0	70.8	280							
									50.0	70.5	282	225	0.76					
									55.0	53.5	295							
									60.0	52.0	290	225	0.51					
									65.0	51.0	292							
P-8-4 8-2-67 0900	41°55'40"	81°16'00"	78.0	SSE 6	S 1-2½	green	23.2	77	surface	71.8	275							
									2.5	71.8	275							
									5.0	71.8	273							
									10.0	71.8	274							
									15.0	71.8	275							
									20.0	71.8	275							
									25.0	71.8	275							
									30.0	71.7	275							
									35.0	71.7	275							
									40.0	71.7	275							
									45.0	71.5	275							
									50.0	71.0	276							
									55.0	70.2	280							
									60.0	64.1	290							
									65.0	52.2	289							

									70.0	51.7	290								
									75.0	50.7	381								
P-8-5	41°59'50"	81°15'40"	79.0	SSE 5	S 1-2	green	23.8	81	surface	71.8	272								
8-2-67									2.5	71.8	272								
0945									5.0	71.8	273								
									10.0	71.7	273								
									15.0	71.7	275								
									20.0	71.7	275								
									25.0	71.7	275								
									30.0	71.7	274								
									35.0	71.6	273								
									40.0	71.3	273								
									45.0	71.1	275								
									50.0	71.0	275								
									55.0	70.3	279								
									60.0	68.8	280								
									65.0	52.0	295								
									70.0	52.0	295								
									75.0	51.8	291								
									78.0	51.3	368								
P-8-6	42°04'10"	81°15'20"	79.0	SSE 6	S 1-2	green	21.3	81	surface	71.8	272	80	0.59	8.45	9.0	35.0	0		
8-2-67									2.5	71.8	272								
1030									5.0	71.8	272	80	0.68						
									10.0	71.8	272	45	0.68						
									15.0	71.8	272								
									20.0	71.8	272	70	0.42						
									25.0	71.7	275								
									30.0	71.7	275	30	0.59						
									35.0	71.7	275								
									40.0	71.0	275	135	0.38						
									45.0	71.0	275								
									50.0	70.8	275	180	0.38						
									55.0	70.0	275								
									60.0	62.2	292	180	0.80						
									65.0	54.5	290								
									70.0	52.7	290	265	0.63						
									75.0	51.8	290								
									78.0	50.8	355			7.53	4.0	35.0	32		
P-8-7	42°08'30"	81°15'00"	79.0	S 0-5	S 2-3	dark green	17.3	80	surface	71.9	270								
8-2-67					(swells)				2.5	71.9	271								
1115									5.0	71.9	271								
									10.0	71.9	271								
									15.0	71.9	271								
									20.0	71.8	272								
									25.0	71.8	272								
									30.0	71.5	272								
									35.0	71.5	273								
									40.0	71.4	273								
									45.0	71.1	273								
									50.0	70.8	274								
									55.0	68.3	285								
									60.0	60.2	288								
									65.0	60.2	288								

PROFILE LINE 8 - continued

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-8-7 (con'd)									70.0	51.5	289							
									75.0	50.7	289							
									78.0	50.6	340							
P-8-8 8-2-67 1200	42°12'50"	81°14'40"	78.0	S 0-5	S 1-3 (swells)	dark green	16.2	78	surface	71.3	263							
									2.5	71.2	265							
									5.0	71.2	265							
									10.0	71.2	265							
									15.0	71.2	265							
									20.0	71.1	265							
									25.0	71.1	265							
									30.0	71.0	267							
									35.0	70.8	267							
									40.0	70.8	267							
									45.0	70.2	267							
									50.0	70.0	267							
									55.0	68.8	269							
									60.0	58.5	280							
									65.0	50.8	288							
									70.0	50.7	288							
									75.0	50.6	288							
									78.0	50.0	348							
P-8-9 8-2-67 1200	42°17'10"	81°14'10"	78.0	S 0-5	S 1-3 (swells)	dark green	16.5	82	surface	71.9	267							
									2.5	71.7	267							
									5.0	71.7	265							
									10.0	71.3	267							
									15.0	71.1	265							
									20.0	71.1	265							
									25.0	71.1	267							
									30.0	70.8	267							
									35.0	70.7	268							
									40.0	65.7	273							
									45.0	58.3	286							
									50.0	50.8	286							
									55.0	50.0	290							
									60.0	50.0	287							
									65.0	49.9	285							
									70.0	49.3	290							
									75.0	49.0	287							
									77.0	49.0	327							
P-8-10 8-2-67 1315	42°21'20"	81°14'10"	74.0	S 0-5	S 1-3 (swells)	dark green	14.8	83	surface	70.8	270	205	0.92	8.50	9.0	32.5	3	Bottom material: smooth medium-gray mud.
									2.5	70.8	270							
									5.0	70.7	270	180	0.85					
									10.0	70.7	270	220	0.59					
									15.0	70.7	270							

									20.0	70.2	270	215	0.71						
									25.0	70.0	272								
									30.0	68.8	272	235	0.80						
									35.0	67.8	272								
									40.0	63.8	272	315	0.59						
									45.0	60.2	282								
									50.0	51.9	285	305	0.55						
									55.0	50.9	285								
									60.0	50.0	290	260	0.71						
									65.0	50.0	290	220	0.38						
									70.0	49.9	293								
									73.0	49.9	320			7.57	6.0	30.0	4		
P-8-11 8-2-67 1430	42°25'40"	81°13'40"	73.0	S 0-3	S 1-3 (swells)	dark green	17.5	82	surface	72.7	269								
									2.5	72.6	270								
									5.0	72.5	270								
									10.0	72.5	270								
									15.0	72.1	270								
									20.0	72.0	270								
									25.0	71.9	270								
									30.0	71.9	268								
									35.0	71.2	268								
									40.0	70.8	268								
									45.0	66.7	275								
									50.0	60.3	283								
									55.0	51.3	284								
									60.0	50.2	287								
									65.0	50.0	287								
									70.0	49.9	287								
									72.0	49.8	324								
P-8-12 8-2-67 1500	42°30'00"	81°13'10"	70.0	S 0-3	SSE 1-3	dark green	13.2	82	surface	72.3	265								
									2.5	72.0	265								
									5.0	72.0	265								
									10.0	71.9	265								
									15.0	71.8	268								
									20.0	70.8	268								
									25.0	70.6	268								
									30.0	67.7	273								
									35.0	62.8	280								
									40.0	60.1	280								
									45.0	51.5	283								
									50.0	50.7	283								
									55.0	50.5	285								
									60.0	50.3	285								
									65.0	50.3	285								
									69.0	49.8	338								
P-8-13 8-2-67 1600	42°34'20"	81°12'50"	56.0	SSE 0-3	SSE 1-3 (swells)	green	12.5	82	surface	69.0	272	130	0.85						Bottom material: pinkish-gray till clay.
									2.5	69.0	272								
									5.0	68.8	272	135	0.85						
									10.0	68.2	272	140	0.93						
									15.0	67.2	272								
									20.0	52.2	280	180	0.42						
									25.0	51.8	282								
									30.0	51.8	282	95	0.34						
									35.0	51.5	285								
									40.0	51.0	285	70	0.46						
									45.0	51.0	285								
									50.0	50.8	285	0	0.34						
									55.0	50.8	285	90	0.59						

PROFILE LINE 8 - continued

Station no. Date Time	Surface observations: Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Depth observations: Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	Remarks
P-8-14 8-2-67 1700	42°38'40"	81°12'40"	35.0	calm	S 1-2 (swells)	green	10.7	80	surface	69.3	270	300	0.76	8.29	9.5	30.0	13	Bottom material: pinkish-gray till clay.
									2.5	69.0	270							
									5.0	69.0	270	270	0.34					
									10.0	67.8	272	355	0.63					
									15.0	66.0	275	315	0.88					
									20.0	60.0	280	315	0.55					
									25.0	58.2	290	285	0.51					
									30.0	55.0	295	285	0.38					
									34.0	55.0	295			8.08	5.0	30.0	7	

PROFILE LINE 9
CENTRAL LAKE ERIE: PORT BURWELL, ONTARIO, TO CONNEAUT, OHIO

Station no. Date Time	Surface observations: Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Depth observations: Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	Remarks
P-9-1 8-3-67 0840	42°38'40"	80°43'20"	18.0	WSW 0-5	WSW 2-3 (swells)	green, cloudy	1.5	77	surface	70.2	265							
									2.5	70.2	265							
									5.0	70.2	265							
									10.0	70.0	269							
									15.0	69.9	272							
									18.0	69.8	280							
P-9-2 8-3-67 0900	42°37'30"	80°48'10"	32.0	WSW 0-5	WSW 3-4 (swells)	green, cloudy	9.3	78	surface	69.2	270	225	0.76	8.48	8.0	30.0	0	Bottom material: smooth gray-brown mud.
									2.5	69.2	270							
									5.0	69.2	270	230	0.55					
									10.0	69.2	270	230	0.51					
									15.0	69.2	270	240	0.71					
									20.0	69.2	270	300	0.55					
									25.0	69.2	278	315	0.59					
									30.0	69.2	278							
									32.0	69.0	278			8.43	9.0	35.0	2	
P-9-3 8-3-67 0950	42°33'20"	80°46'40"	54.0	WSW 0-5	WSW 3 (swells)	dark green	16.3	78	surface	69.5	275	60	0.59					Bottom material: very fine sand and gray silt.
									2.5	69.2	275							
									5.0	69.2	275	180	0.71					
									10.0	69.2	278	180	0.76					
									15.0	69.0	278							

									20.0	69.0	278	250	0.51						
									25.0	64.2	285								
									30.0	55.0	292	270	0.63						
									35.0	53.8	297								
									40.0	53.0	298	315	0.67						
									45.0	52.5	298								
									50.0	51.7	299	350	0.46						
									54.0	50.8	299								
P-9-4 8-3-67 1045	42°29'10"	80°45'00"	66.0	SSW 0-5	SSW 3 (swells)	dark green	14.8	78	surface	70.6	271								
									2.5	70.3	271								
									5.0	70.3	271								
									10.0	70.2	271								
									15.0	70.2	271								
									20.0	70.1	271								
									25.0	69.3	274								
									30.0	69.2	274								
									35.0	68.7	274								
									40.0	52.7	290								
									45.0	51.2	293								
									50.0	51.2	293								
									55.0	50.7	293								
									60.0	50.7	293								
									65.0	50.5	294								
P-9-5 8-3-67 1130	42°24'50"	80°43'40"	67.0	WSW 0-5	WSW 3 (swells)	dark green	13.9	81	surface	72.0	270	60	0.88	8.53	9.0	35.0	2	Bottom material: pinkish-gray till clay.	
									2.5	71.8	270								
									5.0	71.8	270	90	0.76						
									10.0	71.8	270	135	0.76						
									15.0	71.8	270								
									20.0	71.8	270	140	0.97						
									25.0	71.8	270								
									30.0	71.0	275	145	0.68						
									35.0	71.0	275								
									40.0	70.7	275	45	0.59						
									45.0	62.5	280								
									50.0	52.5	290	65	0.59						
									55.0	52.5	290								
									60.0	52.5	290	45	0.55						
									65.0	52.0	290	0	1.05	7.76	4.0	32.5	2		
P-9-6 8-3-67 1220	42°20'50"	80°42'00"	70.0	WSW 5	WSW 3 (swells)	dark green	17.5	82	surface	72.0	270								
									2.5	72.0	270								
									5.0	72.0	270								
									10.0	71.9	270								
									15.0	71.8	272								
									20.0	71.8	272								
									25.0	71.8	272								
									30.0	71.7	272								
									35.0	71.6	272								
									40.0	71.5	272								
									45.0	71.5	272								
									50.0	71.0	272								
									55.0	69.5	274								
									60.0	57.6	285								
									65.0	51.3	293								
									70.0	50.7	293								
P-9-7 8-3-67 1300	42°16'40"	80°40'40"	67.0	WSW 0-5	WSW 3 (swells)	dark green	15.3	82	surface	72.5	260								
									2.5	72.1	260								
									5.0	72.0	260								
									10.0	71.9	263								
									15.0	71.9	270								

PROFILE LINE 9 - continued

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-9-7 (con'd)									20.0	71.8	270							
									25.0	71.8	270							
									30.0	71.8	270							
									35.0	71.8	270							
									40.0	71.8	270							
									45.0	71.8	270							
									50.0	70.5	273							
									55.0	69.3	273							
									60.0	66.0	278							
									65.0	55.5	300							
									67.0	54.0	293							
P-9-8 8-3-67 1340	42°12'10"	80°39'00"	76.0	WSW 0-5	WSW 2-3 (swells)	dark green	16.3	82	surface	72.2	275	70	0.93	8.62	9.0	35.0	0	Bottom material: pinkish-gray clay, probably glacial till.
									2.5	72.2	275							
									5.0	72.2	275	180	0.59					
									10.0	72.0	275	180	0.63					
									15.0	72.0	275							
									20.0	71.8	275	200	0.71					
									25.0	71.8	277							
									30.0	71.8	277	225	0.59					
									35.0	71.8	277							
									40.0	71.2	277	270	0.46					
									45.0	71.2	277							
									50.0	70.8	277	225	0.63					
									55.0	70.0	278							
									60.0	59.0	290	180	0.42					
									65.0	56.3	292	165	0.46					
									70.0	50.3	295	180	0.42					
									75.0	50.0	299			8.16	8.0	32.5	2	
P-9-9 8-3-67 1430	42°08'10"	80°37'20"	79.0	WSW 0-5	WSW 2-3 (swells)	dark green	16.3	80	surface	73.3	280							
									2.5	73.3	280							
									5.0	73.3	280							
									10.0	72.7	280							
									15.0	72.5	280							
									20.0	72.1	280							
									25.0	72.1	280							
									30.0	71.9	280							
									35.0	71.9	280							
									40.0	71.7	280							
									45.0	71.0	281							
									50.0	69.5	287							
									55.0	51.5	307							
									60.0	46.3	300							
									65.0	45.8	300							
									70.0	45.8	300							
									75.0	45.8	300							
									79.0	45.8	300							

P-9-10 8-3-67 1510	42°04'10"	80°35'40"	43.0	calm	W 2 (swells)	dark green	18.8	79	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 43.0	73.3 73.3 73.3 72.7 72.6 72.5 72.5 72.3 72.0 71.0 70.1	283 283 283 283 285 285 287 287 290 290 290							
P-9-11 8-3-67 1550	41°59'50"	80°34'10"	50.0	SW 0-5	WSW 1-2 (swells)	dark green	9.6	78	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 49.0	74.0 74.0 74.0 73.2 73.0 72.8 72.8 72.8 72.8 72.2 72.2 70.5	290 290 290 290 290 295 295 295 295 295 295 295	70 270 315 115 0 90 45 0 0 0	0.71 0.17 0.34 0.38 0.25 0.29 0.25 0.53 0.34 0.34	8.60 8.10	9.5 7.0	32.5 35.0	10 7	
P-9-12 8-3-67 1630	41°57'50"	80°33'30"	28.0	S 5-10	S $\frac{1}{2}$	green, cloudy	8.0	78	surface 2.5 5.0 10.0 15.0 20.0 25.0	74.4 74.1 74.0 74.0 74.0 73.7 73.7	295 295 295 295 295 295 294							

PROFILE LINE 10
EASTERN LAKE ERIE: ERIE, PENNSYLVANIA, TO LONG POINT, ONTARIO, TO PORT DOVER, ONTARIO

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-10-1 8-5-67 0930	42°09'50"	80°02'50"	32.5	NE 5-10	NE 1-2	dark gray-green	9.9	70	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 32.5	73.0 73.1 73.1 73.3 73.3 73.1 73.1 73.5 73.5	285 285 288 288 290 290 290 290 268							Bottom material: fine gray-brown sand with wood fragments.
P-10-2 8-5-67 0945	42°11'20"	80°02'40"	48.0	NNE 5-10	NNE 1-1½	dark green	16.2	74	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 48.0	72.0 72.0 72.0 72.0 72.0 72.0 72.0 71.9 71.9 71.8 71.8 71.8	270 270 272 272 275 275 275 275 275 275 275 275	85 110 120 125 130 135	0.59 0.46 0.42 0.52 0.38 0.46	7.85 8.43	9.0 8.0	35.0 30.0	0 0	Bottom material: sandy dark-gray-brown silt.
P-10-3 8-5-67 1030	42°15'50"	80°01'40"	78.0	NNE 5-10	NNE 1-2	dark green, clear	21.9	76	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 78.0	71.0 71.0 71.0 70.8 70.8 70.8 70.8 70.8 70.8 70.8 70.8 70.7 65.2 54.2 42.0 41.5 41.2 41.2	278 278 275 275 275 275 278 278 278 278 279 279 280 295 305 305 305 305							Bottom material: gray-brown mud.
P-10-4 8-5-67 1110	42°19'50"	80°00'40"	115.0	NNE 5	NNE 1	dark green, clear	22.8	76	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0	71.8 71.5 71.5 71.0 71.0 70.8 70.8 70.5 70.5	275 275 275 275 275 275 275 275 278	130 90 120 90	0.46 0.59 0.51 0.76	8.50	9.0	35.0	0	Bottom material: brown clay, dry and friable, probably derived from till.

									40.0	70.2	278	130	0.68						
									45.0	65.0	285								
									50.0	59.8	292	190	0.39						
									55.0	52.5	295								
									60.0	47.9	300	100	0.24						
									65.0	45.5	302								
									70.0	41.8	305	120	0.29						
									75.0	41.8	305								
									80.0	41.8	305	120	0.29						
									85.0	41.8	308								
									90.0	41.8	308	120	0.34						
									95.0	41.8	308								
									100.0	41.8	308	60	0.34						
									105.0	41.8	308								
									110.0	41.8	308	90	0.63						
									115.0	41.8	308			8.46	9.0	30.0	0		
P-10-5 8-5-67 1215	42°24'20"	79°59'40"	148.0	NNE 0-5	NNE ½	dark green, clear	18.5	73	surface	71.2	280								
									2.5	71.5	280								
									5.0	71.5	282								
									10.0	71.0	282								
									15.0	70.8	282								
									20.0	70.2	282								
									25.0	70.2	285								
									30.0	70.1	285								
									35.0	70.1	285								
									40.0	70.1	285								
									45.0	64.2	290								
									50.0	60.0	292								
									55.0	54.5	297								
									60.0	51.3	298								
									65.0	49.2	300								
									70.0	46.7	300								
									75.0	44.1	305								
									80.0	42.8	308								
									85.0	42.3	308								
									90.0	41.8	308								
									95.0	41.5	318								
									100.0	41.0	318								
									110.0	40.4	318								
									120.0	40.0	318								
									130.0	40.0	318								
									140.0	40.0	318								
									148.0	40.0	318								
P-10-6 8-5-67 1300	42°28'40"	79°58'40"	210.0	NNE 0-5	calm	dark green, clear	30.0	78	surface	72.5	280	110	0.38	8.13	9.0	30.0	0	Bottom material: gray-brown mud.	
									10.0	72.0	280	120	0.38						
									20.0	71.5	280	165	0.56						
									30.0	70.5	280	225	0.41						
									40.0	55.5	278	60	0.46						
									50.0	51.0	280	40	0.46						
									60.0	48.8	295	15	0.59						
									70.0	48.0	300	15	0.81						
									80.0	47.0	300	10	0.88						
									90.0	46.2	300	15	0.55						
									100.0	45.5	303	10	0.85						
									110.0	45.0	305	15	0.88						
									120.0	44.0	305	20	0.59						
									130.0	43.0	305	30	0.51						
									140.0	42.5	305	10	0.51						

PROFILE LINE 10 - continued

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-10-6 (con'd)									150.0	42.0	305	10	0.54					
									160.0	41.5	300	15	0.69					
									170.0	40.0	295	30	0.46					
									180.0	39.2	298	40	0.56					
									190.0	39.2	300							
									200.0	39.2	305							
									210.0	39.2	308			6.82	9.0	30.0	190	
P-10-7 8-5-67 1600	42°32'40"	80°02'30"	11.3	calm	calm	green	bottom visible	80	surface	73.8	272	146	0.47	8.58	9.0	30.0	0	Bottom material: medium to fine sand.
									2.5	73.5	272							
									5.0	73.2	272	260	0.68					
									7.5	71.9	265							
									10.0	71.9	279	240	0.56					
									11.3	71.8	279			8.47	8.0	30.0	0	
P-10-8 8-5-67 1630	42°36'20"	80°04'20"	111.0	calm	calm	dark green, clear	24.0	80	surface	72.8	280							Bottom material: gray-brown mud.
									2.5	72.6	280							
									5.0	72.3	279							
									10.0	71.8	279							
									15.0	71.0	279							
									20.0	70.9	280							
									25.0	70.5	280							
									30.0	70.5	282							
									35.0	70.2	282							
									40.0	64.8	287							
									45.0	59.0	298							
									50.0	58.5	295							
									55.0	58.0	295							
									60.0	58.0	295							
									65.0	57.5	295							
									70.0	55.8	299							
									75.0	55.8	300							
									80.0	51.5	305							
									85.0	40.5	305							
									90.0	40.5	308							
									95.0	40.2	308							
									100.0	40.2	310							
									111.0	40.2	310							
P-10-9 8-5-67 1715	42°40'10"	80°06'50"	53.0	calm	calm	dark green	26.2	83	surface	71.6	285	35	0.39	8.50	9.0	35.0	0	
									2.5	73.3	285							
									5.0	73.0	283							
									10.0	72.0	281	195	0.17					
									15.0	70.8	282							
									20.0	70.5	282	215	0.19					
									25.0	70.1	282							
									30.0	70.1	282	235	0.10					
									35.0	70.0	282							
									40.0	63.3	291	95	0.07					
									45.0	60.1	295							
									50.0	60.0	298	150	0.32					
									53.0	59.2	298			8.42	7.0	32.5	1	

P-10-10 8-5-67 1600	42°44'10"	80°09'40"	34.0	calm	calm	dark green	26.5	80	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 34.0	70.7 70.7 70.6 70.2 70.2 69.4 69.2 68.7 63.5	287 287 288 288 290 290 290 290 298	200	1.00 (est.)					Bottom material: sandy brown mud.
P-10-11 8-5-67 1830	42°46'10"	80°11'00"	19.0	calm	calm	green	14.3	76	surface 2.5 5.0 10.0 15.0 19.0	70.0 70.0 70.0 70.0 70.0 69.8	287 287 287 287 287 287							

PROFILE LINE 11
EASTERN LAKE ERIE: PORT MAITLAND, ONTARIO, TO DUNKIRK, NEW YORK

Station no. Date Time	Surface observations								Depth observations								Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-11-1 8-6-67 1000	42°20'20"	79°33'40"	40.5	ENE 5	ENE ½	green	21.0	78	surface	70.3	285	260	0.29	8.25	9.0	31.3	0	Bottom material: reddish-brown till clay, rich in gravel.
									2.5	70.3	285							
									5.0	70.3	285							
									10.0	70.3	283	110	0.08					
									15.0	70.1	283							
									20.0	70.1	282	90	0.15					
									25.0	70.1	282							
									30.0	70.0	282	120	0.21					
									35.0	70.0	282	200	0.14					
									40.0	66.5	293			8.50	8.0	33.8	0	
P-11-2 8-6-67 1100	42°16'20"	79°31'40"	63.0	ENE 5	ENE ½	green	29.3	78	surface	70.5	282	135	0.28					Bottom material: clean medium-grained brown sand.
									2.5	70.5	282							
									5.0	70.5	282							
									10.0	70.5	282							
									15.0	70.4	285							
									20.0	70.3	285							
									25.0	70.3	285							
									30.0	70.2	288							
									35.0	70.2	288							
									40.0	70.2	288							
									45.0	70.1	290							
									50.0	67.8	295							
									55.0	66.0	295							
									60.0	64.5	295							
									63.0	63.0	295							
P-11-3 8-6-67 1130	42°12'20"	79°29'00"	93.5	ENE 5	ENE ½	green	21.0	76	surface	71.0	281	40	0.40					Bottom material: very fine sand mixed in gray-brown mud.
									2.5	71.0	281							
									5.0	71.0	282							
									10.0	70.8	282							
									15.0	70.5	282							
									20.0	70.5	282							
									25.0	70.4	282							
									30.0	70.2	282							
									35.0	70.2	282							
									40.0	70.2	282							
									45.0	70.2	280							
									50.0	70.1	282							
									55.0	67.9	293							
									60.0	66.2	290							
									65.0	65.1	295							
									70.0	62.5	288							
									75.0	60.5	298							
									80.0	54.2	295							
									85.0	53.8	302							
									90.0	49.8	298							
									93.0	49.0	315							

P-11-4 8-6-67 1230	42°08'20"	79°26'40"	95.0	ENE 5	ENE ½	dark green	21.8	80	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0 95.0	71.0 71.0 71.0 70.8 70.7 70.5 70.5 70.5 70.5 70.5 70.2 70.2 70.2 70.1 66.2 59.5 55.8 53.0 52.5 52.4 52.0	285 282 282 282 282 282 282 282 282 282 282 282 282 282 295 284 300 295 303 303 303 (probe in mud)	275 130 135 115 95 345 20 125 190 200 	0.34 0.12 0.12 0.14 0.10 0.15 0.17 0.49 0.27 0.20 	8.74 7.20	9.0 6.0	35.0 30.0	0 15	Bottom material: gray-brown mud.
P-11-5 8-6-67 1300	42°04'20"	79°24'20"	100.0	ENE 5	ENE ½	green	20.7	76	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0 95.0 100.0	72.0 72.0 71.9 71.5 71.4 70.8 70.5 70.5 70.3 70.1 70.1 70.1 70.1 64.1 58.5 51.9 51.5 50.0 49.2 46.5 46.5 46.5	270 270 275 275 278 280 280 281 282 282 282 283 283 280 295 285 300 300 305 305 300 315 (probe in mud)							Bottom material: gray-brown mud.
P-11-6 8-6-67 1400	42°00'30"	79°22'10"	64.0	NNE 5-10	NNE ½-1	green	14.3	76	surface 2.5 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 52.0 55.0 60.0 64.0	73.5 73.5 73.5 73.5 72.8 72.0 72.0 71.9 71.8 71.0 70.8 70.5 69.5 59.2 49.5 49.5	280 280 280 280 279 275 280 280 280 280 280 280 280 295 300 295	255 195 210 240 240 30 variable 235 	0.24 0.20 0.29 0.17 0.19 0.22 0.21 	8.60 8.08	9.0 8.0	30.0 30.0	0 0	Bottom material: dark-gray-brown mud with fine sand.

PROFILE LINE 12
EASTERN LAKE ERIE: STURGEON POINT, NEW YORK, TO POINT ABINO, ONTARIO

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-12-1 8-7-67 1155	42°42'10"	79°02'20"	38.5	SW 5	SW ½-1	green	14.3	77	surface	72.8	282	230	0.36	8.44	8.0	35.0	0	Bottom material: very fine brown sand.
									2.5	72.5	282							
									5.0	72.5	282							
									10.0	72.3	282	230	0.27					
									15.0	72.3	282							
									20.0	72.2	282	260	0.29					
									25.0	72.0	285							
									30.0	72.0	285	260	0.24					
									35.0	72.0	285	270	0.17					
									38.0	71.8	285			8.57	8.0		0	
P-12-2 8-7-67 1240	42°45'50"	79°04'00"	63.0	SSW 5	SW ½-1	green	19.0	78	surface	73.5	263	80	0.46	8.09	8.0	30.0	0	Bottom material: silty gray-brown mud.
									2.5	72.5	265							
									5.0	72.5	265							
									10.0	72.1	280	70	0.24					
									15.0	72.0	280							
									20.0	71.9	280	165	0.25					
									25.0	71.8	282							
									30.0	71.8	285	230	0.27					
									35.0	71.7	285							
									40.0	71.5	285	330	0.12					
									45.0	71.2	285							
									50.0	71.2	285	290	0.19					
									55.0	71.0	285							
									60.0	70.5	285	325	0.14					
									63.0	68.5	285			8.56	7.5	35.0	0	
P-12-3 8-7-67 1340	42°49'30"	79°05'30"	32.5	SSW 5-10	SW 1	green	16.9	78	surface	72.8	282	100	0.44	8.50	9.0	35.0	0	Bottom material: limestone bedrock.
									2.5	72.0	285							
									5.0	72.0	285							
									10.0	71.9	287	115	0.46					
									15.0	71.9	285							
									20.0	71.5	290	90	0.29					
									25.0	71.0	290							
									30.0	70.5	290	140	0.25					
									32.0	70.5	287			8.52	9.0		0	

PROFILE LINE 13
NIAGARA RIVER AT BUFFALO, NEW YORK

Station no. Date Time	Surface observations								Depth observations									Remarks
	Latitude	Longitude	Water depth (ft)	Wind direction and velocity (mph)	Wave direction and height (ft)	Water color (visual)	Transparency (ft)	Air temperature (°F)	Water depth (ft)	Temperature (°F)	Conductivity (micromhos/cm)	Current direction (compass °)	Current velocity (ft/sec)	Hydrogen ions (pH)	Dissolved oxygen (ppm)	Chloride ions (ppm)	Turbidity (jtu)	
P-13-1 8-7-67 1530	42°54'00"	78°54'30"	16.5	SW 10-15	SW ½	green, clear		78	surface	71.5	282	40	7.85	8.43	8.0	37.5	0	
P-13-2 8-7-67 1550	42°56'20"	78°54'50"	17.0	SW 10-15	SW ½			77	surface	72.8	282			8.28	8.0	32.5	0	
P-13-3 8-7-67 1600	42°56'10"	78°54'30"		SW 10	calm			77	surface	72.0	305			8.01	6.0	37.5	0	